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E.W.O. and the Foundry Industry

By the middle of May, the Essential Work Orders will not apply to the bulk of the engineering trades, but it will still be applicable to the iron foundry industry. We do not quite know whether to be pleased or sorry about this. By its retention, manufacturers of iron castings will theoretically be free from the wholesale exodus to join the ranks of dockside labourers or municipal transport undertakings. Again, theoretically, they will have directed to them the class of labour still remaining capable of being directed. The fact that it is an industry essential for the well-being of the country, does seemingly lend weight to the need for the continuation of control. On the other hand, this fact can be considered as casting a slur on the industry, which in itself is not helpful either in the retention of existing manpower or the recruitment of additional help. In actual practice if a man really wishes to leave the industry he will find ways and means of attaining his object, and in any case disgruntled individuals are not too helpful either in maintaining or attaining high production. Naturally, the reactions will vary according to locality. In a town predominantly engaged in foundry work, repercussions will be at a minimum, but in localities where there is just one foundry amongst other types of trade, then an adverse effect on contented employment may be experienced.

It was our pleasure during the war to talk to many dozens of Canadian soldiers and all were extremely proud of the fact that they were not conscripts but volunteers. This mental attitude will be shared by the bulk of the engineers after May, but not by the foundry worker. There is, moreover, the possibility that our industry will be bracketed in the minds of the *hoi polloi* with coal mining, which may not be helpful. It is probable that if the Essential Work Order was lifted from the foundry industry there would be need for a national recruiting campaign of greater dimensions than that now envisaged, but the history of the last three decades has impressed upon us the efficacy of these efforts. Kitchener's army; the Derby scheme; Eat More Fruit; the Penny-a-Week Red Cross Fund; the National Savings Campaign; the Salvage Drive, all bear eloquent testimony of what can be done by well-directed publicity. Is it possible that such an action would have better results for the country than the retention of the E.W.O.? We are convinced that the Government are retaining the E.W.O. with the laudable object of helping the country in its present emergency by what they deem to be an aid to the foundries. Yet we have not quite convinced ourselves that measures devised for the successful prosecution of war are quite so suitable under peace-time conditions. It will be evident from what we have written that we have a fairly open mind on the subject, with leanings towards the freeing of the industry from the E.W.O. We have not so far discussed the problem with organised thought within the industry—either employer or trade union, but an expression of opinion at this stage would be helpful. It should be borne in mind that the Board of Trade, the Ministry of Supply, the Ministry of Health, and the Ministry of Labour and National Service are all interested parties and the views of all may not be quite the same, and no doubt the various Ministers would welcome an expression of authoritative opinion from the industry.

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The index to Vol. LXXVII (September-December, 1945) is now ready, and is obtainable on application to the Publisher, FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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FORTHCOMING EVENTS

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

MARCH 8.

Manchester Association of Engineers :—" Drop Forgings," by Lt.-Col. J. W. Danielsen. At the Engineers' Club, Albert Square, Manchester, at 6.45 p.m.

MARCH 13.

Institute of Welding (East Counties branch) :—" Steps in Achieving High Quality Welds," by E. Fuchs. At Ipswich.

Institute of Welding (North London branch) :—" Metallurgical Aspects of the Welding of Light Alloys," by Dr. E. G. West. At East Ham Technical College, at 7.30 p.m.

Institute of Welding (West Scotland branch) :—" Welding of Non-ferrous Metals," by H. Martin. At 39, Elmbank Crescent, Glasgow, C.2, at 6.30 p.m.

MARCH 15.

Keighley Association of Engineers :—" Wheels behind the Wheels " (film). At Devonshire Buildings, Devonshire Street, Keighley, at 7.30 p.m.

MARCH 18.

Sheffield Society of Engineers and Metallurgists :—" The Modern Direct Hydraulic System," by F. H. Towler. At the Royal Victoria Station Hotel, Sheffield, 6.15 p.m.

MARCH 21.

Staffordshire Iron and Steel Institute :—" Malleable Cast Iron," by H. G. Hall. At the Dudley and Staffordshire Technical College, The Broadway, Dudley, at 7 p.m.

MARCH 22.

Manchester Association of Engineers :—Annual General Meeting : " Current Trends in Road Transport Vehicle Design," by D. H. Smith. At the Engineers' Club, Albert Square, Manchester, at 6.45 p.m.

Institute of British Foundrymen

MARCH 9.

Scottish Branch :—" Cupola Operation," by D. H. Young, and annual business meeting. At the Royal Technical College, George Street, Glasgow, at 2.45 p.m.

West Riding of Yorkshire branch :—Prize winning Paper in the S. W. Wise memorial competition. At the Technical College, Bradford, at 6.30 p.m.

Lincoln section :—" Modern Research on Cast Iron," by H. Morrogh. At the Technical College, Lincoln, at 2.45 p.m.

MARCH 12.

Slough section :—" High Quantity Mass Production of Castings," by C. D. Pollard and C. A. Payne. At the Lecture Theatre, High Duty Alloys, Limited, Slough.

MARCH 23.

Bristol and West of England branch :—" The Foundry," by W. McCormick. At the Merchant Venturers' Technical College, Bristol, at 7 p.m.

Lincoln section :—" A Discussion of Problems in Jobbing Ironfoundries," by A. E. McRae Smith. At the Technical College, Lincoln, at 2.45 p.m.

MARCH 25.

Sheffield branch :—" Precision Casting by the Lost Wax Process," by Adam Dunlop. At the Royal Victoria Hotel, Sheffield, at 7 p.m.

MARCH 27.

Birmingham, Coventry and West Midlands branch :—" A Survey on the Mass Production of Small Steel Castings," by W. H. Bamford. At the James Watt Memorial Institute, Great Charles Street, Birmingham, at 7.30 p.m.

London branch :—" The Education and Recruitment of Foundrymen," by Dr. D. H. Ingall. At the Charing Cross Hotel, London, W.C.2, at 7.30 p.m.

MARCH 30.

East Midlands branch :—Annual meeting and short Paper competition. At the Technical College, Derby, at 5 p.m.

Wales and Monmouth branch :—" Production of Tank Wheels in a Mechanised Blackheart Malleable Foundry," by A. B. Bill and J. Peers. At Newport.

SOUTH STAFFORDSHIRE IRON AND STEEL INSTITUTE DINNER

In seeking a solution of present-day difficulties we have become a little like the sick man who loses faith in his doctor and resorts to new and untested so-called " cures," said Sir John McLean Duncanson, commercial and technical director of the British Iron and Steel Federation, at Wolverhampton, when he was speaking at the 80th annual dinner of the Staffordshire Iron and Steel Institute—the oldest organisation of its kind in the world—at which there was an attendance of over 250 people.

He thought it would be striking a false note to assume that, because two major wars had ended in our favour, there was a rosy future for us just around the corner. Bitter experience had already demonstrated to this generation that victory did not necessarily mean a rosy future in material things.

It would be wrong, however, to paint a picture of complete despondency, all over the world—and this applied to the conqueror as well as the conquered—the mind of man was troubled and upset and did not have the same balance about it that it had in times of peace.

" You belong to an industry that put the hallmark of fame on it during the war years," said Sir John.

A new iron and steel industry was being modelled in this country just before the war. The war stopped all progress in that direction—output only was the call of the day—but the time had now come when we must get on with the job of rebuilding, and he had every confidence that, given the opportunity, the job would be well and truly done. Dr. J. E. Hurst presided.

CO-OPERATION IN ENGINEERING

Urging the need for co-operation in the engineering industry, Viscount Davidson, president of the Engineering Industries Association, stated in Glasgow recently that if the industry spoke with the voice of all the partners in it there could be no excuse for interference or control on the part of the Government. Viscount Davidson, who was speaking at a luncheon meeting held to mark the inauguration of a Scottish Regional Committee of the Association, said he believed that the major responsibility for the prosperity of the country would fall to engineering. They were moving into a new world in which individual enterprise, initiative, specialisation, and drive not only must be paramount but must operate within the larger field of national policy. Since he became president of the Association he had been convinced that in matters of policy the engineering industry should speak with one voice. Referring to the suggestion by the A.E.U. for an Advisory Engineering Board, with an independent chairman, he said the trade unions were organised, and he believed that the engineers who owned and managed the undertakings must also be organised.

THE FOUNDRY TRADE JOURNAL has accepted an invitation to become the official organ of the British Steel Founders' Association. A fuller statement will be made later.

THE FEEDING OF CASTINGS*

By R. W. RUDDLE

[SLIGHTLY ABRIDGED]

The subject matter of this lecture is treated from the angle as to why castings require feeding, elementary consideration of the fundamentals underlying the satisfactory feeding of castings and the physico-chemical properties of metals when they solidify. In dealing with the solidification of metals and alloys we have two sets of conditions to contend with: (*a*) The pure metal which has a definite freezing point, and (*b*) an alloy which commences to freeze at one temperature and finishes freezing at a temperature some degrees lower, this range of temperatures being known as the freezing range of the alloy. The extent of the freezing range is some indication as to the amount of feeding which can be given to a particular alloy. Thus, if it was shown that the particular alloy had a narrow freezing range, it would indicate that feeding would be difficult and that, therefore, a large feeding head would be required, whereas where a wide freezing range was shown, probably only a riser would be required, such as is common with cast iron. It is surprising to find certain castings, made in reputable foundries, which by virtue of either their size or design, it is impossible to feed or do not actually require feeding, being made with a head or riser attached. In some cases the riser rather aggravates the solidity of the casting instead of assisting it. It is quoted that in one large automobile foundry 500 tons of castings are poured daily into thousands of moulds, without any of this metal going into risers.

It is admitted that with certain alloys the freezing range of the alloy, as shown on a graph, may be misleading due to the physico-chemical properties of the alloy, a classical example being phosphor bronze as compared with, say, gunmetal. To obtain a solid casting in gunmetal, reasonably large heads are necessary, yet with phosphor bronze, in most cases it is useless to place large heads on the castings. It is found on examination of the majority of phosphor-bronze castings, that they are porous and can conclude that gas is probably the reason for the reduced shrinkage. This is partly confirmed by the behaviour of the phosphor-bronze alloy TFF4 which contains 2 per cent. of zinc as compared with BSS421 which does not contain zinc. It is known that when melting alloys containing zinc, a portion of the zinc does volatilise, and the passage of the zinc fume from the metal prevents excessive absorption of oxygen and furnace gases, thus reducing the amount of gas which would be absorbed if the zinc was not present. Castings made in TFF4 are rarely porous, but do require large feeding heads.

When molten metal is poured into a mould, the nature of the mould affects the speed of cooling only, and the same general principles of solidification apply irrespective of the type of mould used. The metal before pouring is necessarily at a temperature above its melting point. On being poured, the metal immediately comes into contact with the cold surface of the mould, and it follows that the metal against the mould wall will immediately freeze, forming an envelope of extremely fine crystals of no particular crystalline form, because of the speed at which they were cooled. The action of the molten metal heats the walls of the mould very rapidly, thus causing an appreciable reduction in the chilling action and subsequent cooling of the remainder of the metal which then proceeds by conduction. This retarded cooling gives time for the formation of definite crystalline forms in the still solidifying metal.

The subsequent freezing proceeds from the outside shell first produced, but does not proceed uniformly, but by pushing up peaks due to the fact that as the more perfect crystals form, they develop as individual units. Each crystal grows out from the solid shell and enlarges itself along the line of least resistance. The easiest direction of growth is at right angles to the face of the mould, into the still molten metal in the centre, taking the form of a tree, the central trunk of which grows to its greatest length and pushes forward until it is stopped by some other crystal. The trunk throws off branches at right angles to itself and these in turn further branches until the whole space is occupied by a lattice of trunks and branches.

The term given to this tree-like structure is "Dendrite" and a structure composed of dendrites is termed a "dendritic structure." The growth of any crystal will proceed until it is stopped by either contact with another crystal or lack of supply of further liquid metal. The result of the collisions of these crystals gives rise to the formation of a skeleton of crystalline aggregates which is surrounded by molten metal. This metal then solidifies by depositing itself round the trunks and branches of the crystals that have already frozen, by thickening them until the contour of the crystal is rounded off and is the final stage of solidification.

Sectional Variations

Again, foundrymen have to contend with castings of different section being poured, creating similar conditions in the mould. Consequently, if the cooling of the mould is not particularly rapid, the temperature of the whole of the metal in the mould may be depressed nearly to its freezing point before the crystals growing out from the sides of the mould have had time to extend themselves into the centre of the casting. If this happens, it follows that the fluid metal, within the outer fringe of the columnar crystals, will freeze quite rapidly. Metal which is cast from a temperature well above its melting point will produce columnar crystals, whereas metal poured at just above its melting point will produce equiaxial crystals, both types of structure producing solid castings. From the foregoing it will be seen that the cause of shrinkage is that as soon as the metal touches the walls of the mould a

*A Paper presented to the Institute of Australian Foundrymen.

The Feeding of Castings

solid sheath of metal is formed which is necessarily cooler than the remaining molten metal. The skin or outer layer is stronger and stiffer than any other part, and as it contracts, sucks the still liquid metal to feed itself according to the usual physical laws of solidification. This contraction causes a diminution in volume of the original metal and gives rise to the familiar pipe cavity if no precaution is taken to compensate for this reduction in volume by the addition of further liquid metal.

Pouring temperature has a definite bearing on the amount of shrinkage and consequently the feeding necessary, and some indication of the effect can be obtained from the following data on pure aluminium. The density of aluminium at room temperature is 2.703, and on heating progressively decreases to 2.55 immediately before melting (658.7 deg. C.) and when just molten 2.382. On further heating to 800 deg. C. it is further reduced to 2.34, while at 1,100 deg. C. it is 2.262. This reduction in density is indicative of the continued expansion of metal on heating, and therefore the excessive shrinkage which would be encountered on cooling from temperatures well above the melting point. Almost all metals and alloys behave in a somewhat similar manner, and one can therefore expect excessive shrinkage from other metals and alloys when poured hot.

Shrinkage in metals, when subjected to cooling from above their melting points, takes place in three stages, (1) liquid shrinkage, *i.e.*, the reduction in volume which takes place when the alloy at a high temperature in the liquid state is cooled to a lower temperature still above the freezing point; (2) solidification shrinkage, *i.e.*, when the alloy in the liquid state at just above the freezing point is cooled to the solid state, and (3) solid shrinkage, the reduction in volume as the alloy cools from its solidification point to room temperature.

Shrinkage Defects

Three types of shrinkage defects found in castings are:—(1) Shrinkage due to volume reduction on cooling; (2) interdendritic shrinkage, usually applied to non-ferrous alloys; and (3) micro-shrinkage found in certain aluminium and magnesium alloys. Ordinary shrinkage can usually be overcome by judicious use of properly designed feeding heads. Interdendritic and micro-shrinkage are allied to physical changes in the metal and are not usually responsive to ordinary feeding, but can be prevented by controlled melting conditions, composition and design.

Interdendritic shrinkage is usually ascribed to the drainage of the eutectic downward, after crystallisation, and the consequent minute crevices or intercrystalline cavities left in the drained portion of the metal. This fault manifests itself in the form of porosity found after pressure testing and the cause has its genesis in the metal itself, but in some cases moulding technique and pouring temperature tend to aggravate it by attempting to pour a casting in a position which tends to defy one of the natural laws. The drainage of the eutectic can often be noticed in a casting such as a light bushing connected to a heavy flange. In some cases, a hydrostatic test will prove the light section satisfactory while the heavy end will show signs of leakage. Any alloy which has a eutectic with a low freezing point as compared with the general freezing temperature of the metal as a whole will tend to exhibit interdendritic shrinkage.

Micro-shrinkage is the term given to micro-porosity in magnesium castings and in some cases aluminium alloy castings. All alloys with a wide solidification range are liable to intercrystalline porosity, the prevention of which requires experience on the part of the foundryman. In addition to the careful use of chills, special attention must be paid to the method of filling the mould. Solidification, especially with thin-walled castings, begins while the mould is being filled and if a cast structure free of porosity of any type is to be produced, it is essential that every portion of the casting should be in contact with the metal above it during solidification.

Effect of Pouring Temperatures on Shrinkage

The tendency in many foundries is to pour metal on the dull side with the idea of preventing shrinkage. Actually in many cases shrinkage porosity in castings is due to dull pouring, especially in lighter sections, because the metal freezes too quickly to permit efficient feeding. Dull pouring brings about a rapid freezing of the skin of the casting by heating up the cold mould, but does not provide the necessary temperature difference between metal and mould to establish a proper temperature gradient when freezing is approached. Pouring at low temperatures does not permit risers to function properly and further adds to feeding troubles.

High casting temperatures, apart from causing excessive shrinkage, reduce the rate of solidification because the excess heat of the metal is conducted to the mould before the freezing point of the metal is reached. The resulting gradual solidification not only produces a coarse structure, but sometimes promotes segregation. Controlled pouring temperature is therefore essential.

In many cases, the contributing cause of excessive shrinkage in castings is due to unequal sectional thickness, and very often lack of knowledge of correct design on the part of the engineer causes the foundryman much trouble in the production of a sound casting. Where a riser is employed on a casting, ferrostatic pressure is employed to more or less force the crystals of the semi-plastic metal together. Cast iron is a typical material which has a wide freezing range and passes through a pasty stage in which the metal is partly liquid and partly solid. Following the usual behaviour of alloys during solidification, the first crystals which form on the walls of the mould, known as "chill crystals," are comparatively low in carbon and the remaining metal therefore richer in this element. These primary dendrites gradually grow larger in layers and each succeeding layer is richer in carbon, and finally at the eutectic temperature the residual material solidifies. Dendrites, if allowed unrestricted growth.

such as through lack of feeding, adopt a fern-like structure and can often be discerned on the surface of a shrink cavity. The presence of the above-mentioned chill crystals on the surface of the iron casting accounts for the extra strength obtained when testing a test-piece unmachined, as compared with a test-piece turned down from a larger diameter bar.

It is worthy of mention, at this stage, that there is an optimum speed at which any casting may be cooled, to prevent shrinkage cracks in the chill crystals. Difficulty was recently encountered in the production of copper billets cast in chills for subsequent rolling into sheets. The chills were water cooled, and the copper, when poured into the cold chills, could not be rolled without cracking. Examination revealed shrinkage cracks at the edges of the billets, due to too rapid cooling. The conclusion arrived at was that the chills were too cold and trial batches were made in warm chills which proved perfectly satisfactory on rolling.

Case of Steel Castings

Regarding steel castings, theoretically the best method of filling a mould with steel is to pour the metal straight down the sink head and fill the mould slowly. The heavier sections should be above the lighter, in order that the top may freeze last and feed the lighter sections. However, while this method may be theoretically desirable it is not applicable to sand moulds, particularly in green sand. The stream of metal falling on to the sand would erode it, and the loosened sand would wash into the corners of the mould, become trapped and cause a dirty casting. Also any cores in the metal stream would be ruined. Therefore it is the usual practice to pour the metal down a runner exterior to the casting itself and into the mould cavity through ingates at or near the bottom. While this precaution ensures that the metal will enter the mould cavity in the safest manner, filling the mould from the bottom, it means that the first metal entering the mould eventually finds its way into the feeding head where theoretically we should have the hottest metal to assist feeding.

The foundryman sometimes tries to compromise by stopping pouring when the metal is in the head and pouring hot metal directly into the head. This method is accepted as a necessity in non-ferrous alloys such as manganese bronze. Why is it not practised more regularly in steel foundries?

In the case of a tall casting the upper portion may cool to such an extent that feeding heads become almost useless as such, due to the dullness of the metal when it reaches the top of the casting. In such a case it is imperative that a series of ingates be used at several levels, although the use of these ingates sometimes causes loose sand to be trapped within the casting. It was previously mentioned that many thousands of castings are produced in iron without any provision for feeding. The same applies to many small steel castings, where feeding is practically impossible due to section. Malleable cast-iron moulding practice is a classic example and certain steel foundries specialising in small castings are tending to adopt the malleable moulding practice where the "Yankee" runner, as it is commonly known, is being used to act as both runner and feeder. The design of feeding heads and their location must be affected to produce the following results:—(*a*) The maximum amount of feeding will be done during pouring by the hot metal running into the mould at the correct pouring speed; (*b*) by the heavy sections of the casting which feed the lighter sections below them; and (*c*) by the feeding heads during the time that they are being filled with fresh hot metal.

The ideal casting is one which can, by virtue of its design, contract with freedom and an ingot may be cited as a typical or ideal casting. An ingot is usually large and heavy, cast in a vertical position, and owing to its uniform cross section, will pass from the liquid to the solid condition without evidence of irregular shrinkage except the usual shrink cavity or pipe in the centre of the ingot near the top. In the case of the ingot there is the assistance of gravity to obtain sound metal in the bottom of the ingot.

It must be understood that, in commercial practice, ingots are actually fed in order that as great a length as possible will be solid and usable. If an attempt is made to cast the ingot on its side, edge up, a shrinkage defect will occur at this top edge, as in this case the effect of gravity is not so noticeable although shrinkage has proceeded in a fairly uniform manner.

Correct Feeding Essentials

For the correct feeding of a casting, the essentials of the heads are as follow:—(1) A reservoir capable of holding sufficient metal to satisfy the reduction in volume; (2) an open passage to admit this metal to that portion of the casting which requires to be fed; and (3) locating the feeding head in such a position that it will feed the last portion of the casting to solidify.

Considering requirement (1), the reservoir must be of such dimensions that the metal in it will remain liquid until after the casting has set and thus be able to supply molten metal when it is required as shrinkage progresses. Requirement (2) requires the passage connecting the feeding head with the casting to be of such a dimension that after allowing for a certain area of this passage which will freeze rapidly, there will remain a sufficiently large opening to admit the feeding metal until the casting solidifies and is fed completely. Requirement (3) requires the feeding heads to be placed over the last portion of the casting to solidify, usually the heaviest section. In some cases this is not always possible owing to the design of the casting or the method of manufacture of the pattern, and in such cases other means must be found to ensure solidity of the casting. For certain alloys, chills may be used to assist in obtaining solidity by accelerating the freezing of the heavier sections, thus leaving less work for the feeding heads to perform.

It must be decided by the foundryman to what extent chills may be used and this decision can only be the result of past experience. The next consideration is the size of the head to be used in relation to the metal section to be fed. As previously mentioned, the feeding value is only as efficacious as the open area of the neck, as once the neck has frozen feeding ceases.

The neck of the feeding head should be as short

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as possible. The law of fluid pressure operates in a feeding head, and therefore a head should always be higher than wide for efficient feeding. Any feeding head will only continue to feed the casting as long as the neck remains open and the surface of the head remains fluid. In an ordinary design of head, use is made of the pressure of the atmosphere as well as the force of gravity. Unfortunately, one had to contend with the law which states that nature abhors a vacuum. This condition arises when the feeding head freezes on its surface, even if the neck is still open, and when this takes place a vacuum is created under the recently frozen skin. Various means have been tried in an endeavour to keep the head open, such as covering the surface with some insulating material, such as keiselguhr or some carbonaceous material such as powdered coke, charcoal, sawdust or chaff. The use of carbonaceous materials cannot be recommended as the steel absorbs the carbon, and in some instances this higher carbon material finds its way into the casting and in certain steels creates hard spots giving rise to complaints in the machine shop.

The Williams System

Taylor and Rominsky in the U.S.A. approached the problem in a novel manner by mechanically keeping the feeding head open to the atmosphere, thereby making use of the atmospheric pressure until the casting was fed or until the neck froze. Their method (invented by Williams) was the insertion of an oil sand core, the bottom end of which was located in the centre of the feeding metal. The skin of the head therefore could freeze, but the core being porous would still admit the atmospheric pressure. It is well known that the atmosphere will support a column of mercury approximately 30 in. high. The specific gravity of mercury is 13.5 and that of iron 7.0, therefore it can be assumed that the pressure of the atmosphere would support a column of liquid iron 52 in. high. Actually, Taylor and Rominsky worked on the principle of the blind riser, with the modification of the insertion of the core to admit the atmosphere. The presence of a large feeding head, superimposed on a casting, necessitates its final removal by means of a cutting torch followed by grinding to make the casting presentable, and to overcome this disadvantage experiments were conducted placing the feeding head at or near the bottom portion of the mould. From the analogy of the barometer it will be seen that pressure would be exerted for a height of at least 52 in.

The shape of the feeder was then given attention, and the sphere was finally used as it has the least surface area of any geometrical shape. Castings poured in this manner were sectioned and found to be perfectly solid. One steel foundry organisation which has applied this method of feeding wherever possible, estimates that a saving of 50 per cent. in head metal and 75 per cent. in fettling costs has been achieved. Experimental castings in certain non-ferrous and light alloys have been made in the foundry at the Technical College, Melbourne, to test the applicability of this system of feeding, with quite encouraging results. Further work is being carried out to obtain data on the volume of the feeding sphere and area of the ingate in relation to the weight and volume of the casting, and it is hoped to present this data in the form of a Paper to the Institute at a later date.

The author believes that this work of Taylor and Rominsky has been the most outstanding contribution to the foundry industry for many years, and he regrets that some action has not been taken by any other foundry institutions officially to recognise it as such. The actual application of the atmospheric feeding is a modification of the well-known blind riser. The blind riser in most cases was used to supply feeding to some heavy section low in the mould which by nature of the design of the casting could not be satisfactorily fed from a top riser. The blind riser was in the interior of the mould and thus has no access to the pressure of the atmosphere and very little assistance from the force of gravity, because the shell of the blind riser freezes similarly to the casting and creates a vacuum in the riser, therefore little feeding is affected.

To break the vacuum the riser is vented by inserting through the mould and into the riser, a rod of some permeable material which is so placed as to reach through and well below the skin of frozen metal at the mould surface and by its permeability permits the transmission of the atmospheric pressure. As previously mentioned, these rods may be of sand, but a more recent development is the use of graphite rods. These rods are placed in the risers so that the rising molten metal completely surrounds them. As a consequence the freezing temperature of the metal is lowered by the absorption of carbon and the combustion of some of the graphite, both reactions increasing the fluidity of the steel. In blind risers the graphite burns out, leaving a hole in the side of the riser to admit the atmospheric pressure. As previously stated the use of carbonaceous materials is not recommended for certain steels on account of the undesirability of carbon absorption. The saving in weight of feeding metal can be appreciated from the following figures:—

Typical casting weighing 31 lb.		
Old method using 1 riser	6½ in. ϕ 7 in high	66 lb.
New method using 1 riser	3 in. × 5 in. × 7 in.	31 lb.
	Saving—35 lb. or 66 per cent.	
Casting weighing 144 lb.		
Old method using 1 riser	9 in. ϕ × 10 in. high	180 lb.
New method using 1 riser	7 in. ϕ × 8 in. high	87 lb.
	Saving—93 lb. or 51 per cent.	
Casting weighing 188 lb.		
Old method using 4 risers	3½ in. × 5 in. × 8 in.	168 lb.
New method using 4 risers	2 in. × 4 in. × 10 in.	96 lb.
	Saving—72 lb. or 43 per cent.	

In these cases the riser has been superimposed on the casting and the atmospheric core inserted in the same. This method in some cases may be preferable to the use of the sphere for convenience in moulding, but this method of feeding still requires the same amount of work in the fettling shop whereas with the sphere only the small ingate into the casting requires

to be removed. When using the graphite rods in place of sand cores, the following diameters of rod have been found to produce satisfactory results:—

Risers up to	3 in.	$\frac{3}{16}$ in. dia. rod.
	3 in.-5 in.	$\frac{1}{4}$ in. „ „
	5 in.-8 in.	$\frac{5}{16}$ in. „ „
	8 in.-12 in.	$\frac{3}{8}$ in. „ „

In passing, it is interesting to record how the density of an alloy can vary due to efficient feeding. It is recognised that the centrifugal method of pouring a casting is the most efficient in obtaining a clean and solid casting. A gear blank was made as a sand casting and another of identical dimensions was centrifugally cast. The sand casting, apparently quite solid, weighed 37 lb. while the centrifugal casting weighed 41 lb. From this it can be assumed that so called solid castings are not so solid.

In conclusion, the Author would point out that he has purposely refrained from dealing with the feeding of any particular type of casting in any particular alloy, and in mentioning early in the Paper the solidification of cast iron, did not refer to the expansion which takes place due to graphite precipitation as the chief purpose of the Paper was to present more the essentials to satisfactory feeding than to obscure the issue with technical explanations.

ENGINEERING UNIONS AND RECONSTRUCTION

Representatives of engineering industry unions have put before Mr. John Wilmot, Minister of Supply and Aircraft Production, a series of proposals for the reconstruction of the industry. The proposals included a demand for an advisory engineering board composed of equal numbers of representatives of both sides of the industry with an independent chairman. The board should be appointed by, and be answerable to, a single Minister responsible for Government policy in relation to engineering. Mr. Wilmot assured the deputation that he was the Minister wholly responsible for engineering. He raised questions on the suitability of such a board for an industry as diverse as engineering, but his mind, he said, was open on the matter, and the deputation undertook to elaborate the proposal in greater detail.

The deputation suggested that the task of harnessing the different sections of the engineering industry to national needs was too complex to be left entirely to Government departments plus the haphazard decisions of private firms, combines, and trade associations. The unions wanted to help and be fully consulted. The Government should take the organised workers more into their confidence, and create machinery which would enable the workers to play their full part.

THE WORKINGTON IRON & STEEL COMPANY, who have taken over the works of the Distington Hematite Company, Limited, are expecting to find employment for 1,200 in a foundry now being built and on the manufacture of mining machinery, etc.

A COREMAKER MAKES A SUGGESTION

By W. G.

There has recently passed through the hands of the writer a number of new and excellently made coreboxes, large and small, out of which hundreds of cores will eventually be made. The boxes are all made in halves, and Fig. 1 shows one of the largest. The coreboxes, on being handed to the coremaker, were immediately criticised by him, while at the same time he suggested a simple improvement which he claimed would reduce time on the job by the cutting out of one operation, necessary if the alteration were not made.

As the castings were for a customer, and the foundry did not employ a patternmaker, the foreman had no voice in the construction of the coreboxes. The suggested improvement was to close in the open ends of

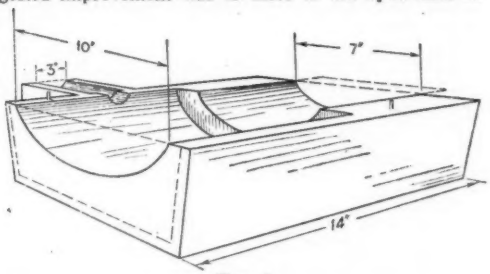

FIG. 1.

the boxes by nailing strips of three-ply board to them, as indicated by the dotted line, which the coremaker proceeded to do when the idea was approved.

This simple addition enabled the operator to ram the sand tight up to the ends of the box, an operation which, if the ends had been open, he would have had to perform after closing the two halves of the box. Also, the closed ends prevented the sand from becoming loose when rapping the box before parting.

FLAME SPINNING

Flame spinning offers many interesting possibilities for the rapid forming of steel, states "Steel," November 26, 1945. Oxy-acetylene flame-spinning as a means of closing and otherwise forming tubes and tubular products is being widely used in place of some slower cold-forming methods. It also eliminates certain deep-drawing operations. Fundamentally, the process consists of heating by an oxy-acetylene flame that portion of the work to be formed. During this heating the work is rotated rapidly. As the correct temperature is reached, a forming tool is forced against the work, shaping it to the desired form.

"FOUNDRY PRACTICE," the house organ of Foundry Services, Limited, in its January-February issue (No. 79) contains articles covering microstructures; fluxes; moulding aluminium alloy castings; and iron-founding.

PLANS FOR CO-OPERATIVE RESEARCH IN THE IRON AND STEEL INDUSTRY

In an address by Sir Charles F. Goodeve, O.B.E., F.R.S., to the Sheffield Society of Engineers and Metallurgists, a review was made of the plans now launched for co-operative research in the iron and steel industry.

Co-operation in research matters has for twenty years been a feature of the iron and steel industry and has extended rapidly in parallel with the broadening outlook of the industry. The setting up of the British Iron and Steel Research Association marks an important further step. Three closely linked yet autonomous bodies serving the iron and steel industry and the people in that industry, the British Iron and Steel Federation, the Iron and Steel Institute and the Research Association, now exist. Between them they are intended to cover all of the required fields of co-operative activity excepting labour relations.

One of the principal objectives of the Federation is to ensure that the industry is efficient and is carried on in a way that is to the national interest, this being the most effective way of securing the well-being of the industry itself. The research association will play its part in economic and statistical research and will advise the Federation, and thus the industry, on the incorporation of the latest knowledge of science and engineering in new works, etc.

The Iron and Steel Institute looks after the technical interests of the people in the industry, such as training, technical information services, publications, conferences, etc. The Research Association will carry out its work using the existing facilities in the country, supplementing these by new research laboratories in specialised topics. Research contracts will be placed with Universities, other research laboratories and with firms. The Research Associations' own laboratories will study iron- and steel-making processes, metal working, such as rolling, drawing, etc., coating of steel, corrosion, etc. In addition, it is expected that firms will throw into the pool of the research association the results of work carried out on their own initiative, as they have done in the past.

It is important to note that the setting up of a co-operative research body such as the Research Association will make the need for strong works' laboratories greater than ever. The University, the Research Association and works' laboratories act in series, and we will run into a serious bottleneck in the application of research unless the works' laboratories are strengthened as the research association grows.

In addition to research, it is one of the prime objects of the research association to provide a mechanism whereby the brains of the people in the industry (and outside in Universities, etc.) can be applied to the benefit of the whole of the industry as well as to that of the particular firm in which they work. To achieve this the research association is setting up in close relation with the whole of its work a system of research committees and sub-committees. Membership of these implies an obligation to apply one's knowledge to the benefit of the whole of the industry. It will also arrange

(*Continued at foot of next column.*)

REVISION OF B.S.497

This revised and enlarged standard for cast manhole covers, road gully gratings and frames was prepared primarily for use in the programme of post-war building and consequently the Committee have had before them the necessity of facilitating mass production. There has been in existence a very wide range of differing designs of manhole covers, etc., and it was therefore considered advisable first to determine the duties required, and then to reduce the numbers and types to the minimum necessary to satisfy these requirements. Designs have been drawn up accordingly and it is hoped that their existence will relieve manufacturers of the difficulties occasioned by the specification of various special features and adaptions with the consequent excessive range of designs and the increased difficulties of pattern making, stocking and distribution. At the same time it was felt that the quality should be controlled by an adequate testing procedure in order to minimise the risk of accidents to vehicular traffic and other road users, whilst attention has been paid to the desirability of limiting the troubles caused by rocking.

The Standard envisages three classes of duty, as follow:—

Manhole covers and frames:—(1) Heavy duty for use in carriageways; (2) medium duty for use in footpaths, verges, carriage drives or cycle tracks, and (3) light duty for use in domestic premises or other places where they will not be required to carry wheeled traffic.

Gully gratings and frames:—(1) Heavy duty for use in main roads; (2) medium duty for use in roads on which there is no expectation of heavy vehicles or fast traffic, and (3) kerb type covers and frames for setting into footpaths and verges.

For the heavy duty covers and gratings, the three-point system of support has been standardised exclusively in order to provide non-rock features; it was considered better to omit circular types of covers and frames because, whilst they may be non-rocking initially, it cannot be guaranteed that this condition will endure. Nevertheless, the cover and frames provide a circular opening. A pattern with a circular cover and frame has been included in the medium duty class as it was felt that the differing conditions of use render it less liable to trouble from this cause.

Copies of this specification may be obtained from the British Standards Institution, 28, Victoria Street, S.W.1, price 3s. 6d. each.

PLANS FOR CO-OPERATIVE RESEARCH

(*Continued from previous column.*)

publications and conferences, confidential inside the industry, so that new equipment, processes, etc., developed by individuals in particular works can be freely described and brought to the attention of all others in the industry who might be able to make use of them.

Plans are in hand to ensure full co-operation with the suppliers of equipment and raw materials to the industry and with the users of iron and steel. The changing attitude of the workman in now demanding tools worthy of the skill of his hands and brains completes the co-operative atmosphere which augurs well for the future prosperity of the steel industry.

A DISCUSSION ON THE BEHAVIOUR OF CHARGE MATERIAL IN THE CUPOLA

When the Paper "A New Method of Investigating the Behaviour of Charge Material in an Ironfoundry Cupola and Some Results Obtained," which Mr. N. E. Rambush and Mr. G. B. Taylor presented to the 1945 conference of the Institute of British Foundrymen, was repeated to the East Midlands branch, the following discussion ensued.

The CHAIRMAN (Mr. G. L. Harbach) said the conclusion from the Paper suggested mild steel melted in a cupola because carburisation lowered its melting point. Was it not more likely that the steel melted (or was dissolved) because drops of molten pig or scrap fell on to it? Table IV only showed 0.58 per cent. carbon in steel specimen No. 4, which was recovered from the melting zone, although in Fig. 13 it was partly melted. It was stated that the large metal drop was analysed, but the analysis was not quoted. Did it include silicon as well as carbon, because the silicon percentage would confirm one way or the other?

Carburisation of Steel

MR. TAYLOR, in reply, said Mr. Harbach suggested that the conversion of the steel from the solid to the liquid state was brought about because the surface of the steel was dissolved by liquid drops of iron and scrap dropping upon the surface. If this theory were to be accepted, then it followed that every molecule composing the steel bar must be bombarded by liquid metal in order that it might be dissolved, and having regard to the relatively short time during which this action could take place, the theory would seem to be untenable. Again, it was found on removing the steel bars that they had assumed a vertical position in the cupola and that in all cases it was the bottom of the bar which had suffered most. He suggested that it was unlikely that the bottom ends only had suffered from impingement of liquid drops of iron and scrap.

On the other hand, the effect of liquid drops of iron and scrap falling upon the steel bars could not be ruled out as being of no consequence, but it was felt that the principal effect would lie more in the direction of carburisation of the steel as a direct result of its contact with liquid drops of relatively high carbon content. Unfortunately, the large metal drop was not analysed for silicon.

Heavy Coke Charges

MR. BUTTERS said that, as these trials were carried out to ascertain the reactions that took place in the cupola, and after having heard of the very careful manner in which these experiments were carried out, it was surprising, to say the least, that such control could be maintained when proof of such irregularities as shown on the slides occurred on everyday cupola practice. He was also surprised at the excessive amounts of limestone and coke, which were in the order of 5.3 and 17.8 per cent. No doubt the coke figure included the bed, which at 54 in. above the tuyeres was also much higher than normal practice. It also appeared very unusual to use split charges of 200 lbs. of coke to 10 cwts. of metal in order to raise the carbon to the desired figure.

MR. TAYLOR agreed with Mr. Butters that from the evidence obtained of the behaviour of the charge materials inside the cupola, it was surprising that control could be obtained. On the other hand, one must not lose sight of the fact that liquid metal was stored up in the well and that, after tapping, the metal was held in a sizeable holding-ladle. There could be no doubt that these factors tended to iron out much of the inconsistency which would otherwise occur. The amount of coke and limestone added per charge was excessive and was to be explained partly by the fact that it was desired to pick up carbon in the melt and also because it was desired to slow down the melting rate of the furnace to meet the demands of the foundry at that particular time.

Slag Ledges

MR. C. A. PAYNE said it was inevitable, when one set out to find the answer to a particular question, that the experimental work carried out raised innumerable other questions, and whilst the Authors had not touched upon them in the Paper, doubtlessly they had been considered. This matter of the coke floating on the metal in the well had been noticed to a very slight extent towards the end of a fairly long blow (5 hrs. or more). Looking through the tuyeres, a very small amount of movement was evident, as the metal and slag layer varied between filling the well and tapping out. It was not considered, however, a normal condition at, say, the start of a blow, and the question was immediately raised as to when this condition first became apparent. Considerable argument was raised when the poking of tuyeres was mentioned, such as the solid packing of coke in the well and the avoidance of slag ledges. Could Mr. Taylor detail the tuyere cleaning practice carried out?

Referring again to the slag ledge, were analyses taken of this ledge to compare with analysis of the slag layer over the metal in the well? As evidence of lime and unslagged ash were obtained at tuyere level, the slag "cover" in the well would obviously contain a very large proportion of such materials, whilst it was expected that the slag ledge would be more the result of attack on the cupola lining. It was appreciated that during the melting process the slag from the ledge would be constantly dripping down into the well, but some marked difference was to be expected. Furthermore, it was the slag "cover" which, in intimate contact with the metal, affected the final chemical adjustments to the melt, and it was this slag which must be controlled in the melting process.

In the examination of the steel test-pieces, whilst such differences as reported were over a comparatively small number of samples, it was noticeable that the lower test-pieces from the outer zone showed a higher carbon at the surface; a greater difference between outside and centre, and the test-pieces from the lower levels of the inner zones showed a lower general carbon content, but apparently more tendency for the carbon diffuse to the centre. This would suggest a very marked difference in temperature, CO_2/CO relationship and the time that the test-piece was at the particular point. With

Charge Material in the Cupola

regard to the free carbon reported in the surface scrapings, was the following tentative suggestion considered tenable? The surface layers of the test-bars were presumably in a pasty condition and either by mechanical process (due to action of steam?) or by a process of carbon absorption, minute particles of coke were intermixed with this pasty later, to be firmly retained when the layer was subsequently quenched. The gouging or scouring of channels through the steel was difficult to visualise as the result of mere fusion and bead formation on the surface of the steel itself. It was suggested that this gouging was mainly the result of molten droplets of pig-iron, having a solvent effect on the steel.

Finally, had the Authors collected any data on the influence of steel content on melting or more properly tapping temperature? What was the average carbon pick-up on the last tap made or on the metal layer from the well—a layer, presumably, entirely of the material of the special charges?

Tuyere Practice

MR. TAYLOR, in reply, said the practice adopted in cleaning the tuyeres consisted of opening a small sight hole in the tuyere and poking with an iron rod until the adhering slag was removed from the face of the tuyere. Each tuyere was poked in turn and the cycle of operations repeated every half-hour. This method was not altogether satisfactory, because it was quite impossible to dislodge all the slag from the tuyere. Since completing the tests, boot tuyeres had been fitted, which enabled the blast to be shut off from each tuyere in turn, and this had been found to be a much more satisfactory way of keeping the tuyeres clean.

With regard to the formation of the slag ledge, he agreed that the slag formed here differed from the slag "cover" and that erosion and fusion of the lining were the factors most concerned with its formation. He could not agree that it was the slag "cover" alone which affected the final chemical adjustment of the melt. The nature and physical condition of this slag cover was certainly of great importance, but the formation of the slag ledge must also be a very important factor, since it was found that, due to its formation, the effective area of the cupola in the melting zone was reduced to one-half. This must have caused very considerable change in the melting conditions which, in turn, would be reflected in the analysis. He appreciated Mr. Payne's theory concerning the presence of free carbon on th surface of the steel pieces, and he had no reason to doubt that this offered a possible explanation. With regard to the effect of steel content on tapping temperature, he had no data available, but, in general, it might be said that high steel charges invariably resulted in the metal being tapped 100 to 150 deg. C. hotter than when no steel was charged.

Coke Size and Quenching

MR. P. A. RUSSELL endorsed Mr. Harbach's point as to the dissolving of the solid steel by liquid drops of cast iron, but pointed out that it could not be the whole explanation, as it was possible to melt 100 per cent. steel. Continuing, he said that more emphasis should be laid on the effect of water quenching on coke size. The Authors had found mostly very fine coke opposite and below the tuyeres, whereas if one looked through the tuyeres whilst the cupola was running, or examined the "drop" at the end of the melt, little fine coke was observable. He queried whether the coke really floated on the iron in the well in view of the weight on top of it. Did the slab of iron removed from the well contain any coke?

MR. TAYLOR said in reply that there was little that he could add to Mr. Russell's remarks. It was indeed surprising to find that the coke in the bed was so very small, but he had merely reported upon what was found. It was, of course, possible that the effect of water and steam during quenching might have been to some extent responsible for this disintegration. The slab of solid iron removed from the well did not contain any coke whatever.

MR. H. PINCHIN said Mr. Taylor had given really interesting information regarding the appearance of the steel test-pieces after melting had commenced. Could he give similar information as to the appearance of the pig-iron in the charge after it had reached the point in the cupola where melting commenced?

MR. TAYLOR said, so far as the appearance of the pig-iron in the charge was concerned, it could be said that by the time the pigs reached the melting zone they, like the steel test-pieces, had assumed a more or less vertical position. Their general appearance was similar to the steel inasmuch as the bottom portion melted away first, incipient fusion having occurred on the surface higher up.

On the proposal of Mr. P. A. Russell, seconded by Mr. H. Pinchin, the lecturer was cordially thanked by the members.

I.N.C. REPORT

The Ironfounders' National Confederation, 2, Caxton Street, Westminster, S.W.1, have issued a very comprehensive and interesting report to the members. It covers the creation of the Joint Iron Council, the activities of the Council of Ironfoundry Associations, including the Five-Year plan; costing, transport and standardised conditions of sale.

The Report pays a good deal of attention to education and outlines the existing position. Other sections cover labour; amenities in foundries; Government orders; new British Standards; and the Control Commission for Germany. Altogether this is a really useful and helpful Report.

ORGANISED BY THE Solid Smokeless Fuels Federation, an exhibition carrying the rather awkward title of "Good Heating for Every Home," opens at the Royal Horticultural Hall, Vincent Square, London, S.W.1, on March 13 and closes on March 30. As will be gathered from the character of the organisation only solid-fuel burning apparatus is being shown.

MOULDING LARGE MEEHANITE CRANKSHAFTS

By GEORGE JOHNSTONE,
Foundry Superintendent, Cooper Bessemer Corporation,
Grove City, Pennsylvania

There are three distinct methods of casting large crankshafts, which can be briefly described as follow:—(1) Vertical pouring and cooling; (2) horizontal pouring and vertical cooling, and (3) horizontal pouring and horizontal cooling. The advantages and disadvantages of each of these three methods will be discussed below.

Vertical Pouring and Cooling

Any crankshaft poured in a vertical position must of necessity be gated from the top of the mould to the bottom and the metal fed into the mould cavity progressively from the bottom up. This entails the hazard of erosion of sand from the down-sprue in varying degrees, depending upon the height the metal must drop before entering the first ingate. It is, therefore, very difficult to prevent sand and slag from entering the mould, and after gaining access to the mould, these inclusions may become trapped in many places, due to irregularity of mould contour, thereby scrapping the casting.

It has been proved, particularly on shafts of extreme length, that pouring and cooling in this manner renders impossible the obtaining of uniform physical properties from one end of the shaft to the other. While a progressive vertical gate does feed hot metal into the mould as it fills up, the temperature of the mass in the mould cavity naturally decreases as it rises to the top of the mould. Speed of pouring also has a marked influence on temperature variation between the bottom and top of mould, as all ingates connected to the down-sprue must be kept small enough to by-pass inclusions as the metal rises in the down-sprue. This means relatively slow pouring speed, with consequent increase of temperature loss. Shafts poured in this manner must be topped with a feed-head or shrink-head, designed to dimensions suitable to the particular shaft involved. In solid shafts, where design is such as to facilitate good shrink-flow, relatively sound castings can be obtained.

In shafts where pins and journals are cored in such a manner as to create quick changes in metal sections, and where throws are separated by comparatively short journals, the shrink-head functions effectively in the first throw, but due to rapid changes of angle from one throw to the next, each successive lower throw cools more or less as a separate casting. The results of this are shrink cavities and hot-tears usually found adjacent to the heaviest section of the throw.

Finally, shafts poured and cooled vertically present complex sand problems, due to exposure of the bottom of the mould to the hottest of the metal and to the effect of ferro-static pressure which is naturally greatest at the bottom of the mould. It is extremely difficult to prevent burn-in, particularly where pin and journal cores of small diameters are surrounded by metal of heavier section than the cross-section of the cores. This necessitates resort to cores made from high hot-strength, low-permeability sands, which resist penetration to a much greater degree, but due to latent collapsibility, prevent normal shrinkage, and are indirectly responsible for shrink areas and hot tears.

Briefly to summarise the above, it can be stated that vertical pouring and cooling presents hazardous gating, unbalanced temperature of metal throughout the mould with resulting decline in physical properties, unbalanced feeding in cored shafts, highly dangerous coring, and expensive cleaning.

Horizontal Pouring and Vertical Cooling

The prime objective in this method is fast, quiet introduction of metal into the mould while horizontal, followed by raising the mould to a vertical position as quickly as possible in order to obtain full benefit of head pressure, while the metal is still in a molten state. This method of pouring has a decided advantage over the first method discussed, in that pouring speed can be greatly increased due to elimination of the height factor, with consequent removal of erosion hazards. Traps and skimmers are easily located throughout the gating system, whereby there is virtual assurance of clean metal entering the mould cavity. Down-sprues must be placed at the extreme end of the mould, adjacent to or beyond the top of the shrink-head, to eliminate possibility of run-out after the mould has been raised. This entails the definite disadvantage of flowing the metal the complete length of the shaft, with resultant loss of temperature at that end of the shaft opposite the runner box.

This method of cooling is again satisfactory in solid shafts of favourable design, but, as in the first method, is unsatisfactory in cored shafts with rapid change of metal section and relatively short journals. In the latter case, each throw is again prone to cool as an individual casting, the top throw reaping the benefit of the feed metal above it, and consequently being free from defects, while each succeeding lower throw feeds to some extent upon itself with consequent shrinkage or hot tears again evident. By raising the shaft to a vertical position, the effect of ferro-static pressure again becomes apparent on the bottom of the mould, rendering necessary the use of high hot-strength cores, involving hazards and disadvantages as described in method 1.

To summarise this method of pouring and cooling it can be stated that horizontal pouring ensures clean metal entering the mould, increases pouring speed and consequently favours uniformity of metal temperature throughout the mould. Vertical cooling again entails unbalanced feeding in cored shafts, highly dangerous coring and expensive cleaning.

Moulding Large Meehanite Crankshafts

Horizontal Pouring and Horizontal Cooling

The prime objectives of this method of pouring and cooling are:—(1) Fast, quiet introduction of metal into the mould; (2) distribution of metal from centrally located sprues so that metal of uniform temperature is available to all parts of the mould, and (3) uniform pressure throughout the entire length of the mould whereby cooling conditions are balanced in all throws, thereby ensuring uniform physical properties in the entire casting.

Horizontal casting, as previously described in method 2, lends itself most readily to very fast pouring. In that the mould is to remain in a horizontal position; pouring speed can again be somewhat accelerated by locating the runner box and down-sprues at the exact centre of the mould, the metal being distributed from this point in opposite directions through the runner system, and finally into the mould cavity. A good example of pouring time differential between vertical and horizontal gating methods on two identical shafts of the design (shown in Fig. 1), was 55 secs. for the vertical shaft, and 17 secs. for the horizontal shaft. Shafts poured in the latter manner and speed greatly minimise dissipation of temperature due to progressive contact with cold mould surfaces during the pouring process. This one factor is very important in obtaining uniform, high physical properties.

Crankshafts embodying hollow design and relatively uniform metal section throughout can be cast horizontally without risers or shrink-heads providing:—(1) That the diameter of internal cores is at least 50 per cent. of the outside diameter of the shaft; (2) that metal section surrounding the cores does not exceed 2 in., and (3) that webs are so designed as to maintain approximately the same metal section used in pins and journals.

When these conditions cannot be obtained and design demands rapid sectional changes, risers or shrink-heads must be used. The purpose of fast pouring is defeated to a great extent where open risers must be used because of the absence of pressure due to riser openings. In a mould containing no outlets or openings, the metal is poured into what can be considered a vacuum, and when filled receives full benefit of ferro-static pressure exerted from the sprue and runner box height. Furthermore, in multi-throw shafts of extreme design, it is necessary to use large numbers of risers, which add greatly to the casting cost. Blind or sealed risers have been used experimentally, but in most cases fail to give desirable results in that their size is definitely limited and they tend only radically to increase section.

Inasmuch as there is balanced pressure on all parts of the mould when cast horizontally, and that pressure being divided over a much greater area makes possible the use of relatively soft cores of high permeability and low hot-strength. These cores naturally collapse very rapidly, offer no resistance to contraction of the metal, thereby eliminating to a great extent the possibility of hot-tears and abnormal shrinkage conditions.

Horizontal pouring and cooling presents many advantages over the first two methods described, and

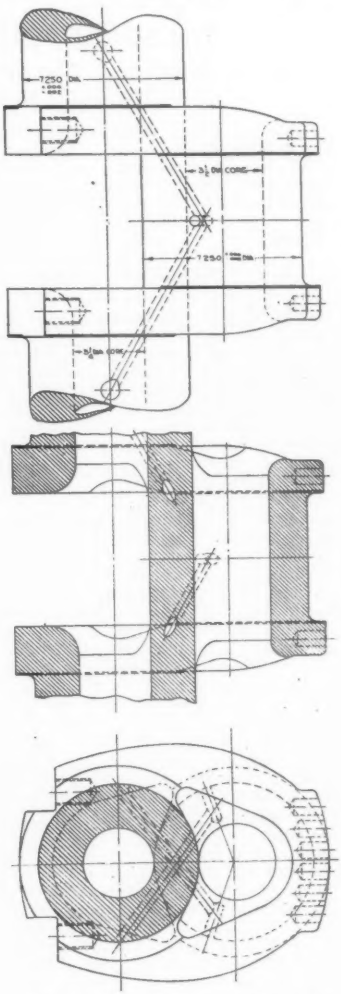

FIG. 2.—IDEAL THICKNESS SECTION IN CRANKSHAFT DESIGN.

these can be summarised as follows:—(1) Very fast pouring with minimum of temperature loss; (2) balanced

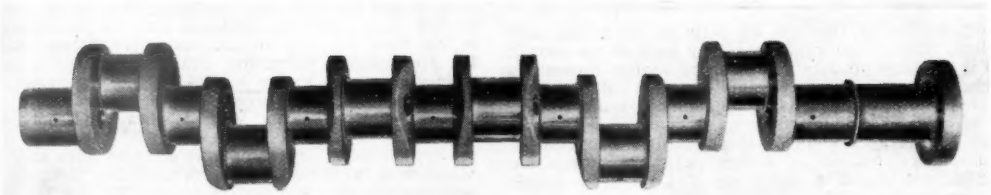

FIG. 1.—TYPE OF CRANKSHAFT DISCUSSED.

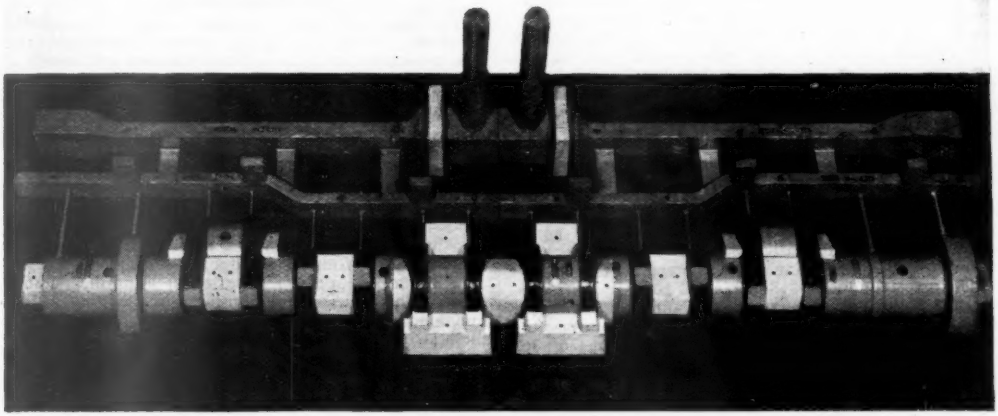

FIG. 3.—COPE PATTERN AND EQUIPMENT FOR THE PRODUCTION OF CRANKSHAFTS.

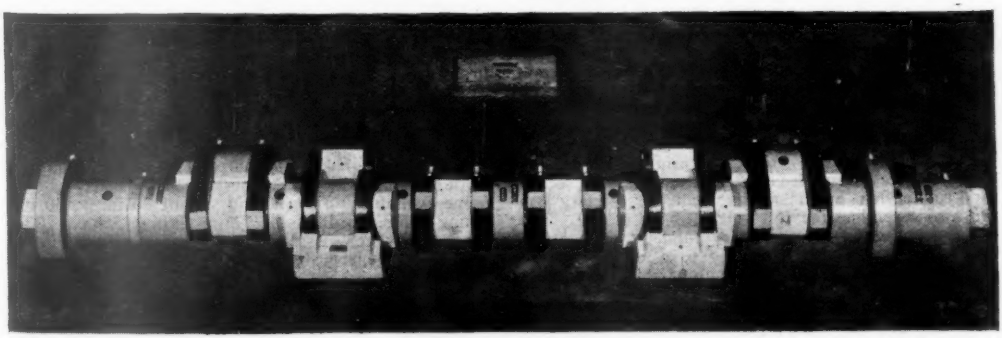

FIG. 4.—THE DRAG PORTION.

Moulding Large Meehanite Crankshafts

distribution of metal to all parts of the mould with little temperature variance at any part of the mould; (3) balanced pressure and balanced cooling throughout the entire mould whereby uniform physical properties are readily obtained; (4) adaptability to quick-collapsing cores offering no resistance to contraction and normal shrinkage, and (5) much greater economy of production because of higher yield percentage, simplicity of moulding operations, and relatively simple cleaning, due to absence of penetration.

Regardless of how crankshafts are poured and cooled, obtainance of sound castings becomes increasingly difficult when design is such as to present rapid change of angles, throw positions, and metal sections. Experiments conducted during the past year have proved conclusively that when a shaft can be cored out to present uniform metal sections in pins, webs, and journals, the most serious casting hazards are eliminated. It has also been proved that the best cooling conditions are obtained when cores are so designed as to follow lines parallel to the section they hollow out. An ideal cross section is embodied in one of our Diesel crankshafts shown in Fig. 2.

Details of Foundry Practice

Foundry practice applied to crankshafts with 7¼-in. dia. pins and journals was, and is, as follows:—

Moulds.—All moulds are rammed by Speed-slinger or bumper, ensuring uniform ramming of the entire mould, in flasks specially designed to promote uniform cooling. Moulding sand is prepared from Millville gravel containing 18 per cent. clay and presenting the following properties:—Moisture 6.5 per cent.; green permeability 120 (average); green compression strength 14, and A.F.A. grain fineness average of 36.

Moulds are coated with graphite base blacking mixed to 40 deg. Boumé on all surfaces exposed to metal. Moulds are thoroughly oven-dried and allowed to cool to room temperature before pouring. One coat of silica wash is applied to all exposed mould surfaces before pouring.

The gating system consists of two 3-in. down-sprues feeding into a large catch basin, flanked at either end by skimmer cores so designed as to permit only 60 per cent. of the sprue metal through their openings. This catch basin effectively prevents any slag, eroded sand, or other foreign inclusions from going beyond its confines. The catch basin is located at the exact centre of the mould and metal is forced from it in opposite directions into a primary runner bar extending the full length of the mould. From this primary runner the metal is forced through connecting gates into a secondary runner bar much smaller than the primary bar and also extending the full length of the mould. The ingates connecting the secondary runner to the mould cavity are spaced approximately 6 in. apart and are so designed as to minimise spouting, with consequent lack of turbulence. Pressure is built up progressively in the gating system from sprues to ingates. The combined area of connecting gates between runner bars is considerably less than the area of the primary runner bar. The area of the secondary runner bar is considerably less than the combined area of the connecting gates, and the combined area of the ingates is less than the area of the secondary runner bar. By progressively decreasing dimensions from sprues to ingates, great pressure is built up and slag or other inclusions have no chance of entering the mould.

Cores.—Port Crescent washed silica sand, bonded with oil to a ratio of 1 part oil to 80 parts sand is used on all cores. The properties of these cores are:—Moisture 7 per cent.; green permeability 140; dry permeability 255; dry shear strength 120; dry tensile strength 130; dry transverse strength 32, and A.F.A. grain fineness average of 48. All cores are coated on metal surfaces with two coats of silica wash after drying, and are allowed to cool to room temperature before being secured in the mould.

Structural Durability

The basic importance of good design as an essential to sound foundry practice has already been emphasised. The principle is not new. Understanding and co-operation from designing engineers have always been indispensable to any intelligent foundry operation. What is comparatively new in the Author's experience is a means for measuring accurately the profound effect of good foundry design on the strength of the resulting casting. Research work in experimental stress analysis indicates that operating stresses which will later be imposed on the finished structure follow some of the same laws that govern the behaviour of fluid metal in a mould. To a fascinating degree the design which is best from a foundry standpoint is also best for the distribution of operating stresses in a finished crankshaft. This efficient relationship gives casting a formidable position in competition with forging as a method of large crankshaft manufacture.

NEW CATALOGUE

Mechanical Shake-outs.—A 20-page brochure, just released by Sterling Specialties, Limited, of Sterling Works, Bedford, appears at a time when it should be of maximum utility, as the question of the reconditioning of foundries is uppermost in the minds of all foundry owners. The opening pages invite the scrapping of the old dust and steam-raising methods, and thereafter the reader is systematically introduced to a wide range—actually seven sizes of machines, which automatically separate sand from boxes and castings under conditions which lend themselves to the easy institution of sanitary conditions.

On page 4, five logical reasons are listed for the installation of shake-outs, but a sixth is the saving of clothing coupons—quite important in these days! The range available is from a grid size of 30 in. × 30 in., taking 3 h.p., to 48 in. × 72 in. taking 15 h.p. The brochure, which is attractively presented in cream and blue, is generously illustrated both by line drawings and photographs.

CANADIAN STEEL CONTROL has been re-established on a temporary basis to meet the situation arising from the United States steel strike.

MILLING OF ENAMELS*

By A. BIDDULPH

Milling Theory

Various workers have established over the past 25 years, the main theory of ball mill grinding. Although earlier workers with experiments on materials other than enamels assumed that most grinding took place by impact, later workers agree that with enamel frit in closed mills most grinding is accomplished by attrition, by nipping or squeezing of the particles of frit between the pebbles, and the movement of the pebbles over each other with entrapped frit between them. With well-quenched enamel frit the nipping of frit particles between pebbles is enough to secure grinding, and impact conditions which may be required with ore crushing are unnecessary. Particle size of the frit has a great influence upon grinding efficiency. For a given particle size, the angle of nip will indicate the smallest size pebble that can usefully be employed, and within this limit the smaller the pebbles, the more "nip" contacts will be available with any given weight of pebbles. This is borne out by the later works of Sechrist and Fellows in which the greatly improved production from smaller sizes of pebbles is reported.

Angle of Nip

Fahrenweld gives the formula $\text{Cos } \frac{\phi}{2} = \frac{r}{r + \frac{S}{2}}$

where ϕ is a constant, and equal to 17 deg. Thus $S = 0.0222\ r$.

Factors affecting milling efficiency include pebble charge, pebble size, frit charge, water content, slip temperature, mill speed and mill cleanliness.

The pebble charge should occupy 55 per cent. by volume of the mill capacity. With porcelain pebbles at 24 Sp. G.; this may be expressed as 50 lb. pebbles per 1 cub. ft., or with flint pebbles at 2.6 Sp.G. as 54 lb. per 1 cub. ft. of mill. The sizes of pebbles will vary between 1 in. and 2½ in. dia., according to the mill diameter, and will be mixed in proportions by weight.

Pebble Size

Mill Dia.	Pebble Dia.
1 ft.	80 per cent. 1 in.; 20 per cent. 2 in.
2 ft.	80 per cent. 1½ in.; 20 per cent. 2 in.
3 ft.	75 per cent. 1½ in.; 25 per cent. 2½ in.
4 ft.	40 per cent. 1½ in.; 40 per cent. 2 in.; 20 per cent. 2½ in.

Unless frit particles are insufficiently quenched the use of sizes larger than 2½ in. is unnecessary and will result in decrease of efficiency through reduction in the number of "nip" contacts.

The *frit charge* should be sufficient to fill the voids between the pebbles. As the pebbles occupy 55 per cent. of mill volume and the voids between pebbles are 40 per cent. of the apparent pebble volume, then apparent volume of frit should be (40 per cent. of 55 per cent.) = 22 per cent. of mill volume. This is equivalent to between 21 lb. and 23 lb. frit per 1 cub. ft. of mill volume with actual Sp.G. of frit between 2.4 and 2.6 as shown, together with pebble charge, for any size of mill in Fig. 1.

Water Content

The final condition in which the enamel slip is required imposes limitations on the amount of water that may be used in grinding. Sechrist found that a white frit for sheet steel, milled with 7 per cent. clay, 2 per cent. tin oxide, and with water varying between 30 per cent. and 45 per cent. gave fastest grinding at 35 per cent. water, which is approximately

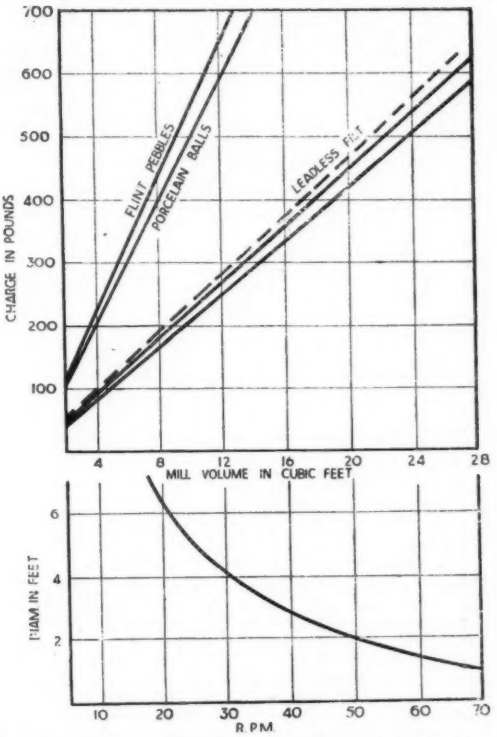

FIG. 1.—(UPPER GRAPH.) FRIT AND PEBBLE CHARGE.
FIG. 2.—(LOWER GRAPH.) MILL SPEEDS.

*A Paper read before the Institute of Vitreous Enamellers.

Milling of Enamels

the amount which would give an enamel slip of the correct consistency for spraying.

A series of tests for the purpose of this Paper give results that do not support Sechrist's findings, although they are concerned with a different type of frit. A steel groundcoat frit was used which when ground in normal practice is prepared for dipping at 1½ oz. per sq. ft. by addition of water to a total of 60 per cent. of the weight of frit. Six jar mills of identical size and pebble charge were loaded with standard weights of solid, and water content varied between 35 per cent. and 60 per cent. of the frit weight. All mills were run together in one frame for a normal period, after which the water content was made up to 60 per cent. and the mills run for one minute for mixing after which they were unloaded.

The determination of residue from the whole milling on 40 mesh, and from a 50 c.m. sample on 200 mesh indicate that most efficient milling was obtained with water content 45 per cent. to 55 per cent. of frit weight. Further millings were made in duplicate with the

TABLE 1.—*Variation of Fineness of Grinding with Change in Water Content.*

Mill addition—

Ground coat frit	100
Pipe clay	7
Borax	0.75
Water	Variable

Mill No.	1	2	3	4	5	6
Initial water	35	40	45	50	55	60
Added water after grinding	25	20	15	10	5	Nil
Total water	60	60	60	60	60	60
Residue on 40 mesh	8	7.75	0.9	0.5	0.7	7
" " " "	8	8	1.0	0.7	1.0	6
Ml. water on 50 ml. after 24 hours	6	6	2	2	1	3
Fineness 50 /200ml. mesh ml.	12	11	10	4.5	3.5	11
" " " "	11	10	10	4.0	4.0	10

same mills, varying water content between 45 and 57.5 per cent. and making up to 60 per cent. for unloading.

The results shown in Table 1 indicate that most efficient grinding is attained with this mill addition at 55 per cent. water content, although there is rather more underground frit than with 52.5 per cent. water. However, this underground frit is probably due to the small size of pebbles used, and is not found in production grinding of this frit with 55 per cent. water in mills of 300 lbs. and 1,500 lbs. using pebbles up to 2½ in. dia. From the foregoing it is shown that where dipping or spraying conditions permit, a water content of 50 to 55 per cent. frit charge should be used to obtain the most efficient milling.

Temperatures

The grinding of enamel frit between the pebbles generates some heat, but with mills properly loaded and running at correct speed, the heat generated does not raise the temperature of the charge unduly except where local conditions of climate and proximity to furnaces or driers produce a high initial mill-room temperature. Factors that tend to produce overheating include too low a frit charge, too low a water content, and too high a slip viscosity. Any factor which increases the power required for grinding will tend to generate heat and thus raise the mill temperature.

Mill temperature has considerable effect upon the solubility of frit during grinding, especially in the case of some super opaque enamels, and should be kept below 90 deg. F. Hansen has specified the range 65 to 80 deg. F., but it is not often necessary to give much attention to the lower limit of milling, as the heat generated will prevent temperature falling too low. In storing enamels, however, it is essential that temperature is not allowed to fall below 45 deg. F. or recrystallisation of sodium borate from the mill liquor is likely to occur with undesirable effect upon the fired surface. If mill-room conditions are such that mills tend to run hot they may be cooled by directing a spray of water on the mill shell during grinding, or by installing water jacketed mills such as are available from most leading manufacturers.

Mill speed is a matter upon which various authorities do not agree. Mellor and Kendall each give formulæ based on pottery practice which produce mill speeds which are in agreement with normal practice for large diameters, but rather slow for smaller diameters. Davis and Fahrenwald have given efficient milling speeds as dependent upon critical speed. Fellows has shown that a mill having a critical speed of 60 r.p.m. was originally rated by the makers at 36 r.p.m., but was run at various speeds up to 70 r.p.m. being 116 per cent. critical speed, with great reduction in grinding time, and no deterioration of enamel slip. Wear on pebbles and linings was not measured and it would appear that there remains some work to be done on this subject. Experience to date suggests mill speeds as detailed in Fig. 2.

Mill Cleanliness

Mill cleanliness concerns the amount of enamel slip left in the mill from previous charge. It can amount to 10 or more per cent. of the charge and if not removed will retard grinding in two ways, by making the new charge too big and by increasing the viscosity due to a greater proportion of fines. Whenever a ground slip is of high viscosity, the last few pounds should be cleared from the mill by adding sufficient water, turning the mill over twice and draining out. The slip may be left to settle off the excess water and later added to the batch. It is known that in certain plants the mills are completely washed out and drained dry between each milling charge to ensure that the following charge shall be exactly proportioned. This is a refinement that is not usually necessary, but is an indication of the trend of good practice.

Mill-room Layout

The mill rooms should be planned with a full understanding of the operations to be performed, and within a full appreciation of the weight of a bag of frit. Factors influencing mill-room layout are:—(1) Storage

of frit and other materials; (2) loading the mills; (3) unloading the mills; (4) storing the enamels; (5) supply of enamel to spray line; (6) repairs to mills; (7) cleaning down; (8) sludge settling and removal, and (9) room temperature.

The provision of adequate facilities of storing frit, grinding, sieving and storing enamel, while it may be a high first charge, will make possible the most economic production of enamel slip. It is false economy to have mills so few or so small that frequent charging or changing is necessary. Most straight forward working is obtained when a mill is charged and unloaded once a day or thereabouts; and the possibilities of contamination through left over frit particles are eliminated by having only one frit ground in any one mill. Whatever the size or number of mills, the general aim should be to lift the frit once only and to let gravity do the rest of the work. An arrangement that has most advantages is shown diagrammatically in Fig. 3.

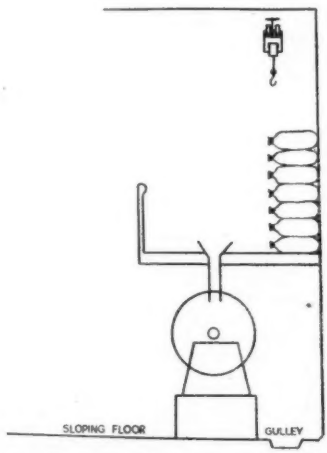

FIG. 3.—ADVANTAGEOUS LAYOUT FOR MILL ROOM.

The frit is usually received in bags of 100 lb. net. These are unloaded from the wagon by electric hoist and stacked to a height of about 5 ft. on the mezzanine floor above the mills in which the frit will be ground. This stock will represent about one week's supply. The mezzanine floor is sufficiently high to give clearance to the mill plus the unloading cock.

The mill is mounted on pedestals sitting upon steel or concrete blocks to give sufficient clearance below the mill for a vibrating screen and enamel bin. Thus the process of milling involves lifting down the bag of frit from the stack, emptying through hopper in mezzanine floor into the mill below. Clay and other ingredients are weighed and tipped through the hopper, and water measured in a calibrated tank is run through the hopper hole. After grinding and testing, the mill is unloaded through vibrating 40-mesh sieve into clean bins of about 25 imp. galls. capacity (300 lb. white frit charge). This method of unloading may be modified by including a magnetic separator, and unloading under pressure of about 5 lb. per sq. in. through 2 in. rubber hose. In this case the enamel from the mill will pass over the magnetic separator, through the vibrating screen into the bin. By suitable unloading cocks the whole of the contents of the mill can be unloaded in this way just as easily as unloading by gravity.

Mill Equipment

As in many other sections, the best equipment is the cheapest to operate. Much good enamel has been and still is ground in mills driven by belt from a countershaft, but the modern trend is for individual motor drive by V-belt or through gears. Timing of grinding is more exact with individual drive and power consumption can be kept more in line with the amount of useful work achieved. Linings are tending to be all of porcelain block, though silex linings when properly fitted give longer life and are still favoured by many enamellers for ground coat milling. Similarly flint pebbles are generally being replaced by porcelain balls, though the best quality flints when obtainable give very effective grinding. Porcelain balls, however, when properly made and fired are generally more uniform in texture and hardness, and have less ill-effect upon enamels if breakage occurs. Rubber linings have been suggested, but trials have not yet produced results to justify a change from porcelain linings. Rubber plugs, however, have distinct advantages over the usual porcelain plug with its iron bolt head becoming exposed after half the plug has worn away.

Mill plugs require very careful maintenance to ensure the best working conditions, and longest life of the lining. Mill linings will all wear out in time, but in many cases they are damaged unnecessarily by execessive wear on the plug, which allows the lining around the loading vent to be worn much more than the rest of the lining. For this reason the plug should always protrude into the mill further than the lining so that the lining is saved at the expense of the plug. When the plug has worn down to the level of the lining, it should be replaced. By this means the life of the lining can be extended by 100 to 200 per cent. resulting in fewer shut downs for repair and much lower maintenance costs. The price of a porcelain plug is about one-fiftieth of the cost of a re-line. If rubber plugs be used the higher first cost is soon recovered, as they last for several years with daily running. Other items of equipment are discussed under mill-room layout.

Storing of Frit

Storing of frit is usually a simple matter, as the modern trend of all enamellers to buy frit from specialists rather than attempt to make their own has established the 100-lb. bag as the unit of frit storage. Other mill ingredients should be stored in closed bins plainly labelled. An accurate scale to weigh up

Milling of Enamels

to the largest single ingredient weight should be mounted where the ingredients can readily be weighed and unloaded into the mills. The scale should be inspected regularly to ensure accuracy.

For measuring water a tall tank with outside glass tube, calibrated in half gallons is recommended. Water meters in the pipe line are not always dependable, nor are float indicators. The tank should be so placed that the water level can easily be read, and is used by filling to the required mark and then emptied by pipe line into the mill. Where mills have individual motor drive a time switch fitted to the starter ensures that milling times are accurately gauged. Full testing equipment in duplicate should be available with a master sieve for regular check on routine sieves, which latter tend to become corroded by some electrolytes, and may be choked with particles of frit lodging in the apertures to such an extent that the residue on the sieve is 200 per cent. in error.

Milling Practice

Godliness is next to cleanliness in all enamelling operations, but especially so in the mill room. It is good practice to discharge the pebbles once a month, and thoroughly wash them and the mill lining for examination. In discharging the pebbles they should not be allowed to drop on to the floor, but dropped into a barrel half full of water to break the fall. The mill should be turned with the filler hole midway between top and bottom when pebbles are replaced. Dropping pebbles into an empty mill from the top can cause severe damage to the lining opposite to the hole.

The lining should be examined for soft spots and for sign of wear around the filler hole, at corners, and at joints in the lining. Any sign of the shell being exposed should be cause for putting the mill out of commission until it has been re-lined. The pebbles are examined for breakage, and all that have worn to less than 1 in. are replaced by a suitable quantity of larger sizes to bring the pebble charge up to specification. Mills of 25 lb. charge can use pebbles slightly less than 1 in.

The unloading cock is provided for unloading and should not be used as an alternative plug. After examination and return of the pebbles, the mill is loaded by putting in half the frit, then all the clay and other ingredients followed by the rest of the frit and finally the water. Before any frit is put into the mill, however, the weights required should be written out, either on a mill card which is attached to the mill frame or in a book. The establishment and maintenance of mill records written out at the time of operations rather than at the end of the day facilitates the detection of those errors which even the best enamellers may commit.

Once the mill is loaded and running, the period of grinding may be estimated from previous experience, but care is necessary to ensure that the grinding period is adhered to. In most mill rooms the filling and emptying of mills is performed during the day and grinding at night. If time switches are fitted, the grinding period can be determined exactly, but if watchmen or operatives from furnaces have to regulate the mills, they should be instructed to start the mills at such a time that grinding will be finished at the time the mill man commences his next day's work. Underground enamel can easily be milled further, but overground enamel is a waste.

When the milling period is completed, a test of fineness should be made by removing the filler plug and taking a sample of ground enamel with a ½-pint ladle, avoiding any unground frit that may be adhering to the filler hole. The sampling of mills through the air vent is not recommended. If the fineness is within the limits, a fired sample of the enamel should be made, and kept on file until the enamel it represents has been used in production.

Mills are unloaded either by gravity, through a vibrating screen into storage bins, or by pressure. With the latter the enamel may be allowed to fall through the vibrating screen as in gravity flow, or may be led through rubber hose to magnetic separator and sieve into bins or into large storage tanks according to the layout of the shop. The wider application of acid-resisting cast-iron enamels of high viscosity has emphasised the advantages of unloading by pressure, and of vibrating screens. When the enamel has drained from the mill, a little water may be added, the mill turned over three times, and a further quantity run off. This can be left to settle off the excess water, and the enamel later added to the bulk. This practice ensures that the mill is empty, and that residual enamel will not retard the grinding of the next charge.

Testing

When a mill has run for the period estimated to produce the required fineness, a test is made by withdrawing a sample through the air vent, or from the mouth of the mill. Several methods of fineness testing are available, single of multi-stage elutriation, and wet and dry sieves using various sizes of sample through one or more standard meshes. An early test was to take 50 ml. of slip and wash through 150-mesh screen, and after drying, to shake away the fines and then transfer the residue to a glass tube marked in units of about 1.5 ml. the number of units being quoted as a measure of fineness.

This was replaced by more exact tests such as the P.E.I. Test using 100 gms. slip on 200-mesh screen, and the A.C.S. Test using a sample containing 100 gms. frit on 100, 200 or 325-mesh screen, according to the class of enamel under test. In each case the residue is dried, fines shaken out, and the net weight in grams is determined. Fineness is expressed as grams residue on appropriate mesh. These tests remain the standards for investigational work where 15 or 20 minutes per test is no disadvantage, but for routine testing of established milling practice a more rapid method is called for and the following was devised some years ago and has been used successfully in several plants.

Apparatus Required.—One 50 ml. glass measure one 3-in. glass funnel; one wash bottle with tapwater;

one funnel stand; one 200 mesh standard sieve 0.029 in. aperture.

Method

The sample of enamel is passed through a 40-mesh sieve and 50 ml. transferred to the 200-mesh sieve. It is washed through the 200-mesh sieve with gently running water until no more fines pass, and the residue is washed to one side of the sieve, which is then held over the funnel and the residue washed through the funnel into the 50 ml. measure. The residue settles in a few seconds and the fineness can be read at once as ml. residue from 50 ml. on 200 mesh. Time taken three to four minutes. A large number

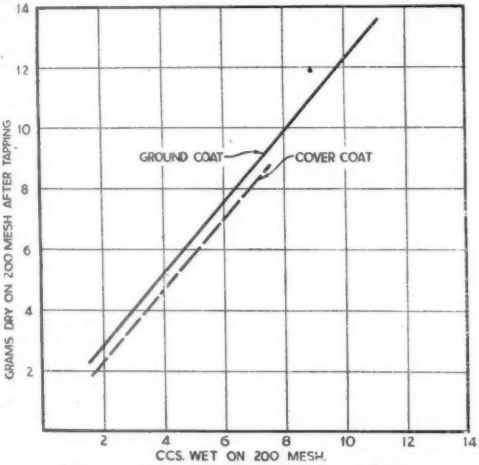

FIG. 4.—DRY AND WET FINENESS TESTS.

of checks between the standard dry method and the wet method here recommended show that for standardised milling practice the relationship is as shown in Fig. 4.

Dip Weight

A freshly pickled light gauge sheet of unit area and known weight is immersed in the enamel slip, withdrawn and hung vertically to drain for a period that may last from 15 to 20 seconds, for a sheet 1 ft. square. The plate is then weighed, dried and weighed again to within $\frac{1}{8}$ oz. and the dry weight expressed as ounces per sq. ft. of iron. In standardised shop practice a dozen such weighings will indicate what wet weight is required to produce the correct dry weight, and for routine testing the rapidity of the wet test is justification for its adoption.

Viscosity

An enamel slip is a colloidal suspension of solids in an aqueous solution, and its yield and mobility are functions of viscosity and plastic flow masked by the solids in suspension. However, the rate of flow of an enamel slip through an orifice is an approximation to the working conditions of enamel passing through a spray nozzle, and, for want of a better term, is generally, though incorrectly, called viscosity.

This is usually measured by filling a 200 ml. brass cylinder with enamel, covering with a cap having an orifice of standard size, usually $\frac{13}{64}$ in. and reversing the cylinder to allow the enamel to flow through the orifice, aided by an air vent pipe. The time in seconds for the flow of enamel is taken as the numerical value of viscosity.

Fired Sample

In addition to tests for fineness, specific gravity and viscosity at the appropriate time, one test should be taken from every mill charge before it is released for use; that is to apply the enamel to a sample plate and fire it. This plate should be filed for reference until the enamel charge it represents has passed through the shop.

Storing and Ageing

The method of storing enamel between milling and spraying is a matter requiring much consideration. It is generally held that each mill charge should be stored separately, when it can be identified, and if necessary segregated in the case of development of any trouble in the shop which may cause it to be suspected. Such storage is usually carried out by running the enamel from the mills into steel bins, of a size similar to the domestic dust bin, which would hold enamel slip resulting from 250 lb. frit. Such bins are readily obtainable fitted with lugs for carrying by truck and are of a size which can later be transported to the spray line for delivery of enamel to gravity or pressure containers. There is much to be said for this method of storage. Also there is something to be said for the method of storage in large permanent tanks whereby the enamel is run from the mill into bins and from there unloaded into the tanks, or alternatively is pumped into the tanks by use of the diaphragm pump. The storage tanks may be of a capacity up to that required to hold several days supply of each particular enamel.

While there are factors favourable to bulk storage as distinct from bin storage, which latter takes a considerable amount of floor space, the advantages of bin storage are generally held to outweigh those of bulk storage on account of the ease of segregation of each milling, and easy transportation to the spray line. In each case, of course, the regular test of the mills before discharge and firing of a sprayed sample of the enamel is rigidly maintained.

Ageing of the Enamels

Considerable difficulties have ben experienced due to lack of ageing of the enamels, on occasions when milling of enamels has been too near the time at which it was required to be used. In the case of ground coats particularly, an ageing period of 24 to 48 hours has definite advantages both for dipping and shaking enamels. If dipping enamels are stored in bulk, control of the ageing is complicated unduly, and if this method is adopted of storing, suitable steps could be taken to overcome the difficulties indicated.

Milling of Enamels

Agitation

Agitation by compressed air is not popular, due to the possibility of contamination of the enamel with oil from the compressed air supply, in addition to which compressed air is rather expensive. Also there is a general feeling that continued agitation with compressed air leads to more rapid loss of set. Agitation is usually mechanical, and in small or medium-sized plants is usually by a paddle wielded by one of the mill-room labourers. When the contents of the containers are agitated in this manner, all containers should be completely emptied before being refilled, and partially emptied tanks should not be replenished by adding fresh enamel thereto. This usually eliminates the possibility of the labourer stirring only the upper contents of the tank, and never getting down to the bottom where the frit may have settled, and where the stirring is more difficult. Containers should be thoroughly cleaned before being refilled; no thick enamel being left on the sides of the container.

Where larger reservoirs or supply tanks are used, the stirring is usually accomplished by means of a large paddle wheel or blunger, operated by individual motor drives, or several agitators might be operated by belts off a line shaft. In most plants the custom would be simply to agitate the tanks for two or three minutes before withdrawing any enamel therefrom at various times during the day, with perhaps a somewhat longer operation the first thing in the morning. Excessive agitation leads to lack of set in the enamel.

Reclaim

The utilisation of dry enamel reclaim from spray booths is a matter of considerable importance as this amounts to anything between 20 to 50 per cent. of the enamel passing through the spray gun. Segregation of the different colours and types of enamel is, of course, of prime importance, but regular collection of the reclaim and its treatment will do much to avoid undue waste. The treatment to be given should be:—(1) Passing through a coarse mesh ¼ in. riddle into a bin containing sufficient water to wet the bin full of enamel; (2) thorough mixing and passing over magnetic separator; (3) testing for suitability by spraying and firing of a sample, and (4) if necessary by adding to a freshly ground charge of similar enamel in the mill and running for an appropriate period to ensure mixing without excess milling. The use of reclaim from cast-iron acid-resistant enamel will often involve the addition of about 1 per cent. of clay to replace that lost in the exhaust line from the spray booth. This can be accomplished in routine treatment by adding a little extra clay to a fresh charge ready for the assumed quantity of reclaim to be added after grinding.

Acknowledgments

Gratitude is expressed to the late Mr. Tom Chambers, who first put the Author "through the mill"; to Mr. G. Steele, and many friends in the enamelling industry, and to colleagues of Ferro Enamels, Limited, for their helpful co-operation over many years.

U.S. MINERAL RESOURCES

On the basis of present knowledge of mineral resources in the United States, there was, stated W. E. WRATHER, Director of the U.S. Geological Survey, Department of the Interior, reason for pessimism as to the supplies of some of the supposedly common metals. Their production during recent years had not been balanced by comparable discoveries of new reserves. The current situation seemed to indicate a trend towards imminent national shortages. This was accentuated by the fact that abnormal war demands required full attention to production and only minor attention to the proving of new reserves—at least in the case of the metals. It should be borne in mind, stated the Director, that under acceptable mining practice, properties were never completely explored in advance of development. Excess exploration was expensive and tied up an undue amount of capital. Therefore the developed reserves at a particular date seldom properly indicated the potentialities of a mine or a district. As a result of the war, proved reserves were indeed dangerously low, and unless the deficiencies were overcome by immediate and successful explorations on a grand scale, it was reasonable to predict that the United States would have to depend more and more upon foreign sources of supply.

LABOUR RECRUITMENT

The Ministry of Labour has acceded to a request made by the Council of Ironfoundry Associations to prepare a film designed to attract labour to the foundries. Pictures are now being taken in various iron-foundries. The C.F.A. has prepared a film strip from the photographs in the booklet, "The Future of Boys in the Foundry," and copies are available on loan to societies, technical institutes, youth centres and the like having suitable projectors. The photographs have been combined to make a very attractive film and a talk has been printed which will be supplied with each copy.

It should be emphasised that the talk and film slide strip are only of limited duration and suitable, therefore, for inclusion in a programme of other interests when this is being shown. This should be beneficial as it may by this means result in an exhibition to audiences which would not otherwise be interested. Applications for loan and further details should be made to the Secretary of the C.F.A., Derbyshire House, Belgrove Street, London, W.C.1.

From the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3, there is available on application a series of excellent lantern slides made from the pictures used to illustrate the recruitment brochure got out by the Manchester and District Ironfounders' Employers' Association.

COL. T. EUSTACE SMITH, assistant managing director of Smith's Dock Company, Limited, North Shields, has disclosed that the company intends to carry out a big scheme of reconstruction and modernisation.

NOTES FROM THE BRANCHES

NEWCASTLE-UPON-TYNE—At the January meeting of this branch, a Paper entitled "Foundry Controls" was presented jointly by Mr. F. Greaves and Mr. N. Charlton, who are both branch members. The Authors presented a system of control from the receipt of raw materials to delivery of the finished castings. Emphasis was laid upon the need for co-operation throughout a foundry and particularly between metallurgical and practical foundry controls. It was evident from a study of the methods advocated that the best production at an economical cost could only result by following the suggested practice.

At a meeting held on February 9, a visit was paid in the afternoon to the "Newcastle Chronicle" works, where modern newspaper production was seen. The quality of the foundryman's work was evidenced in all classes of linotype and printing machinery in use. In the evening a Paper was read by Mr. C. Lashly, entitled "The Buying of Castings." This presented to the foundrymen the consumers' problems, and in the discussion which followed interest was enhanced in a brief address by Mr. F. Wiles, a visitor, who, as a user of castings, asked for complete co-operation between founders and engineers. He emphasised that only by seeing each other's difficulties could certain outstanding problems be overcome.

The next meeting of the branch will be held on Saturday, March 9, at the Neville Hall, Newcastle, at 6 p.m., when a Paper will be read by Mr. W. Winter entitled "Castings from the Point of View of the Engineer."

LONDON.—The honorary secretary, Mr. F. Arnold Wilson, has asked us to call attention to the Short Paper Competition for which entries have to reach him by April 1. Details have been circulated to all members, and members in the East Anglian and Slough areas are especially asked to participate.

MORE BAD PUBLICITY

In a recent broadcast to schools, Mr. Aylmer Vallance said, ... "We're very short, at present of some materials like wood and rubber. So it's difficult to buy, say, matches and motor-car tyres. And then, some jobs—like brick-making, making iron-castings, from red-hot iron in foundries, and so forth—are hard, dirty jobs, and people aren't keen to take them. So there are shortages of a number of things we need for new houses and their fittings."

FOR MONTHS PAST Renfrew Foundries, Limited, have been engaged in the manufacture of various parts of the new all-aluminium austerity motor-car—the 6-h.p. "Kendal." British version of the French "Grégoire." Between 500 and 600 are employed on the car, which weighs only 800 lbs. Prototypes are ready and the "Kendal"—named after Mr. W. D. Kendal, M.P.—should be on the market by the end of May. Priced in the region of £150, including purchase tax, it will be capable of doing 60 m.p.h. and of giving 60 miles to the gallon.

RECENT PROGRESS IN METALLURGICAL WORK IN GREAT BRITAIN

In a Paper which MR. DONALD F. CAMPBELL, M.A., recently presented to the Société des Ingenieurs Civils de France, he first reviewed the iron ore position during the war, and showed how the pre-war production of 12½ million tons was increased to between 18 and 19 million tons. Scrap steel importation, which before the war was of the order of 600,000 tons, was increased to 937,000 tons in 1940; reduced to about 550,000 in 1941, and later, virtually ceased. This, as is well known, was replaced by removing railings throughout the country, whereby some 6,000,000 tons was obtained.

Increased Capacity of Steel Industry

Dealing with the increased capacity of the steel industry, Mr. Campbell disclosed that one new works installed a battery of seven 20-ton Heroult furnaces. He also made the interesting statement that of the hundreds of electric furnaces in operation, the air raids only put out of action one small arc, and two small high-frequency furnaces.

In connection with the production of tank track links and the like, the lecturer disclosed that eight new foundries had been created—usually in iron foundries—for this particular duty. Most of these were furnished with a 4-ton Heroult furnace, as a melting furnace, and an eight-tonner at a lower level as a holding unit. These foundries usually operated with 70 per cent. unskilled women workers. After commenting on the success achieved through the centrifugal casting of heat-resisting steels, the lecturer gave details of how British technicians had not merely solved the problem of replacing styrian magnesite bricks, but by using calcined dolomite and sea water had actually produced a superior refractory. The elimination of tar in the ramming-up of open hearth and electric furnace linings had been achieved by the use of high temperature calcined dolomite, associated with careful grain size selection.

Wider Use of Spectrographic Analysis

The increasing use of spectrographic methods for analysis was commented upon, and full details were given of the development of 1 per cent. carbon, 1 per cent. silicon metal, as a material showing considerable potentialities. The new electrical methods of surface hardening which have been developed were described, and the newer alloys for radiolocation were indicated.

The final part of the lecture was devoted to British research activities, their organisation and functioning, together with some notes on the present position of the industry.

A DINNER was held at the Savoy Hotel, London, W.C.2, on the occasion of the retirement of Mr. John Brown from the post of secretary of the Iron and Steel Trades Confederation. Mr. Joseph Poole, chairman of the Executive Council, presided and among the guests were Mr. G. Isaacs, Minister of Labour, and Sir Arthur Pugh.

EMPLOYMENT ON THE NORTH-EAST COAST

NEW WORKS SCHEMES

During the war very few factories were erected on the North-East Coast owing to its considered vulnerability to enemy air attacks. The building of premises for new industries is, therefore, a matter of vital importance. An article in the "Board of Trade Journal" tells what has so far been done. By the beginning of this year 105 factory building schemes (of which 33 will be financed by the Government) had been approved. They are expected to employ about 30,000 additional people when in full production. It is estimated that the firms moving into the converted ordnance factories at Aycliffe and Spennymoor will employ 7,000, and that a further 6,000 will obtain work with firms which have been allocated Government factories. When fully developed, the new trading estates at Jarrow, South Shields and the Hartlepools are expected to provide employment for 10,000 people. Later the effect of the important I.C.I. project on Tees-side will be felt.

Imperial Chemical Industries, Limited, have acquired a site of over 2,000 acres on the south bank of the River Tees, and it is estimated that over a term of years the developments which are planned will provide work for another 10,000 people.

A. Reyrolle & Company, Limited, switchgear manufacturers, of Hebburn-on-Tyne, are branching out into new lines and have been allocated the Government factory at Ashington, Northumberland, which they operated for the Ministry of Aircraft Production during the war. Thomas Potterton (Heating Engineers), Limited, of London, have taken over a 100,000 sq. ft. factory on the Team Valley Estate. Part of the Scotswood works, Newcastle-upon-Tyne, is to be the home of at least two new industries.

Steel Plants

Dorman, Long & Company, Limited, are to spend £8,000,000 on the construction of a new universal beam mill and a new steel plant on a site of 650 acres between their existing Cleveland and Redcar works on the south bank of the Tees. Pyrotenax, Limited, of Hebburn, are just completing a £100,000 factory for the production of pre-assembled cable units. Darlington & Simpson Rolling Mills, Limited, are building new works at Darlington for the production of metal windows and sections. The Consett Iron Company, Limited, have important modernisation schemes in hand. Palmers Hebburn, Limited, and Whessoe Foundry & Engineering Company, Limited, of Darlington, are carrying out extensive alterations.

Other firms undertaking or contemplating development and extension schemes include the following:—Furness Shipbuilding Company, Limited, Billingham; Cleveland Bridge & Engineering Company, Limited, Darlington; British Ropes, Limited, Gateshead; Anderston Foundry Company, Limited, Middlesbrough; Middlesbrough Casements, Limited; G. Angus & Company, Limited, Newcastle-upon-Tyne; C. A. Parsons & Company, Limited, Newcastle; Allan Kennedy & Company, Limited, Stockton-on-Tees; Le-Tourneau (G.B.), Limited, Stockton; Steels Engineering Products, Limited, Sunderland; Huwood Mining Machinery, Limited, Team Valley; Sigmund Pumps (Great Britain), Limited, Team Valley; Richardsons, Westgarth & Company, Limited, Wallsend; and British Diecasting & Engineering Company, Limited, West Chirton.

ENGINEERING EXPORT TARGET

Appealing for greater production, Mr. John Wilmot, Minister of Supply and Aircraft Production, speaking at a luncheon of the Engineering Industries' Association at the Waldorf Hotel, London, said if this country was to maintain full employment and an adequate standard of living, the engineering industries must produce a proportionately larger part of the national wealth, and help other industries to produce more wealth with limited man-power by providing them with the most modern equipment.

They must play a predominant part in closing the gap in the balance of external payments—namely, in the fulfilment of an increase in the volume of exports of around 75 per cent. It was obvious that many industries on which we had hitherto relied for a substantial part of our exports would not in the long run be able to attain this target. Some might even fall below pre-war level. The engineering industries would have to compensate for this so that their target increase over pre-war exports must be much larger than 75 per cent.

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

"POLYFILM"—Bearings. JARU, LIMITED, River Plate House, Finsbury Circus, London, E.C.2.

"AUTOMETRIC"—Gauges. GROSVENOR ENGINEERING COMPANY, LIMITED, Grecian Street, Salford, 7, Lancs.

"MORGANITE"—All goods included in Class I. MORGAN CRUCIBLE COMPANY, LIMITED, Battersea Church Road, London, S.W.11.

"ULRO"—Machines, machine tools, etc. URQUHART LINDSAY & ROBERTSON ORCHAR, LIMITED, Blackness Foundry, Dundee, Angus.

"FULBOND"—Untreated and treated fuller's earth. FULLER'S EARTH UNION, LIMITED, "Caerlaverock," Nutfield Road, Redhill, Surrey.

"ESDEL"—Fireplaces, domestic boilers, electric accumulators, etc. SWINTON, DICKENSON, LIMITED, 41, Kentish Town Road, Camden Town, London, N.W.1.

A NUMBER OF MEMBERS of the Gauge and Tool Makers' Association will be exhibiting at the International Fair which is to be held in Paris from May 25 to June 10. The Association is arranging for members' stands to be next to one another in the Hall Mécanique in order to give the appearance of a special group or section at the Fair representing British manufacturers of precision tools and gauges.

DALE
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STANTON
DALE Refined PIG IRON
The High-Quality Iron for High-Duty Castings.
Made in seven standard grades or to individual requirements, this iron has a close grain structure and fine graphitic carbon content. It replaces Hematite, and tones up high phosphorus irons.
We also make Dale Refined Malleable Iron to any required specification.
THE STANTON IRONWORKS COMPANY LIMITED
NEAR NOTTINGHAM

EMPLOYMENT IN INDUSTRY

INFLUENCE OF EXPORTS

The total working population decreased in the second half of 1945 by 602,000 to 20,969,000, but was 1,219,000 greater than in mid-1939, according to estimates of the Ministry of Labour and National Service. These figures do not include private domestic service. Of the December total, 750,000 were men and women released from the Forces and still taking paid leave, and 285,000 were insured unemployed, so that 19,934,000 were in the Forces or in civilian employments, of whom 13,931,000 were men and 6,003,000 were women.

The numbers employed in industry were 10,269,000 men and 5,699,000 women, the total being 15,968,000. Between June and December the total number employed in industry fell by 239,000, an increase of 285,000 men being offset by a decrease of 524,000 women. There remained in the Forces and auxiliary services in December 3,859,000, in civil defence, N.F.S., and police 107,000; and employed on the manufacture of equipment and supplies for the Forces 1,790,000, making a total of 5,756,000. (The Ministry says that the number of those given as working on equipment and supplies has been overstated in consequence of mistakes in manufacturers' returns.) Taking into account the fall of 1,494,000 in the total number in employment (including the Forces and industry) there was an increase in employment in the six months of more than 1,858,000 in home civilian industries and services and manufacture for export.

Home Civilian and Export Work

Analysing this figure of 1,858,000 the Ministry points out that the increase on home civilian and export work was in excess of 1,540,000, or 50 per cent. more than the number so employed last June, but was short of the 5,670,000 employed at mid-1939 by 1,089,000, or 19 per cent. The increase during the second half of 1945 was greatest (92 per cent.) in the metal and chemical industries and the number employed in civilian and export work in this group exceeded the number so employed in mid-1939 by nearly 300,000. In mid-1939, however, the figure had been reduced below the normal peacetime level by the beginning of rearmament.

In the other manufacturing industries the increase of employment on civilian and export work during the second half of 1945 was 426,000, or 23 per cent., but the number fell short of the mid-1939 figure by 1,381,000, or 38 per cent. The estimated number employed at the end of 1945 on production of manufactured goods for export was 897,000, compared with 417,000 at mid-1945 and about 1,000,000 at mid-1939.

THE JANUARY "News Letter" received from Allen West & Company, Limited, of Brighton, reviews the war output achieved by the company and indicates some of the activities likely to be undertaken in the future.

OBITUARY

MR. HENRY AUGUSTUS SCOTT BARRETT, for many years managing director of the Wigan Rolling Mills, which closed down soon after the 1914-18 war, died recently.

MR. FRANK HOWARD BUTCHER, managing director of Rowhedge Ironworks Company, Limited, Rowhedge, near Colchester, and of the Wivenhoe Shipyard, Wivenhoe, Essex, died on February 22, aged 60.

MR. HERBERT HUNTING, technical manager at the works of Accles & Pollock, Limited, manufacturers of weldless steel tubes and cold-rolled metal sections, of Oldbury, died at the wheel of his car on February 22. He was 56.

MR. W. H. MCMENEMEY, who rose from engineering apprentice to become a director of Cammell, Laird & Company, Limited, Birkenhead, died on February 24, after a short illness. He retired when engineering manager at the end of 1944, but retained his seat on the board. Mr. McMenemey had been president of the Liverpool Engineering Society and of the Liverpool Royal Naval Architects' and Engineers' Guild, and a vice-president of the Institution of Naval Architects. In June, 1939, the honorary degree of Master of Engineering was conferred upon him by Liverpool University.

COL. HENRY TUDSBERY TUDSBERY, who died at Southdown, Lympstone, Devon, recently, gained the Millar prize, the James Forest medal, and the Manby premium of the Institution of Civil Engineers. After training in the locomotive works and civil engineers' department of the London and South Western Railway he became assistant engineer on Southampton dock works. He was later appointed resident engineer on the Kingston-upon-Thames bridge reconstruction and Southwark Bridge reconstruction. Col. Tudsbery joined the staff of the Roads Department, Ministry of Transport, as director of engineering in 1919. Ten years later he transferred to Birmingham as divisional road engineer, Midland Division, and later he became divisional road engineer, Southern Division. He served for a number of years on various committees of the British Standards Institution.

CONTRACTS OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

Bedlington, March 9—Tools, cast-iron road gullies and manhole covers and frames, for the 12 months ending March 31, 1947, for the Bedlingtonshire Urban District Council. Mr. M. Hall, engineer and surveyor, Council Offices, Bedlington.

Haslingden, March 16—Iron castings, tools, etc., for the year ending March 31, 1947, for the Town Council. Mr. R. Taylor, borough surveyor, Municipal Offices, Haslingden.

Keighley, March 18—Ironwork, etc., during the year ending March 31, 1947, for the Corporation. Mr. R. Courtenay Gibson, borough engineer and surveyor, Town Hall, Keighley.

——but if she worked in a factory she would also love the good lighting without which she could not keep up her high rate of output.

Incorrect lighting is a drag upon workers' health and dulls enthusiasm, whilst correct lighting promotes increased production. If your installation needs better planning or changes are required to take care of new processes, or extensions are necessary——consult the G.E.C.

Take advantage of the knowledge G.E.C. lighting specialists have gained in helping wartime factories towards full production.

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FOR ANY STANDARD OF ILLUMINATION

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NEWS IN BRIEF

THE SUBMARINE "TRIDENT," which broke loose recently in Cardigan Bay, is to be broken up and the steel sent to various steelworks in Monmouthshire for remelting.

EDWARD LE BAS & COMPANY, LIMITED, iron, steel and metal merchants and exporters, announce that their address is now 14, Finsbury Circus, London, E.C.2.

SPEAKING ON THE RESPONSIBILITIES of scientists in modern society at a conference on science and the welfare of mankind, in London, recently, Prof. A. V. Hill urged scientists to refuse to co-operate in tasks in which they or their representatives were not allowed a reasonable share or partnership in the responsibility of deciding on the purpose, policy, or probable result of their work.

RUSSIAN SEAMEN now in this country, who are to take over ex-enemy ships allocated to Russia, have visited the works of Fawcett, Preston & Company, Limited, sugar machinery manufacturers, etc., of Bromborough, Wirral, the Llay Main Colliery, Wrexham, the Prescot works of British Insulated Cables, Limited, and other industrial plants. The visits were under the auspices of the British Council.

THE PARTNERSHIP between John Stanley Bowes, Alfred Montague Bowes and Reginald Edward Bowes, carrying on business as scrap metal merchants at the Goschen Metal Works, Marlborough Grove, Old Kent Road, London, S.E.1, under the style of John Bowes & Son, has been dissolved by mutual consent. The business will be carried on in the future by Alfred Montague Bowes and Reginald Edward Bowes.

AT A MEETING of the Engineering & Lighting Equipment Company, Limited, the resolution put forward by the board dealing with the rights of the preference shareholders was approved. The resolution provided for cancellation of the compulsory fixed annual contribution to the redemption fund. Instead, the directors will recommend at each annual general meeting the amount to be appropriated to the redemption fund.

THE NEED for the whole of the engineering industries being able to speak with one voice on behalf of all engaged in them was stressed by Viscount Davidson, president of the Engineering Industries Association, at a meeting of Scottish engineers at Glasgow. Lord Davidson said he believed that we had a tremendous task ahead if Great Britain was to survive, and to engineering would fall the major responsibility for success or failure.

THREE YOUNG ENGINEERS trained by Glenfield & Kennedy, Limited, of Kilmarnock, have received appointments with the Standard Vacuum Oil Company, Limited in India. Just before the war the Standard Vacuum Oil Company asked Mr. Alex. L. McColl, late chairman of Glenfield & Kennedy, Limited, to send out to them some young engineers for their ocean terminals in India and Ceylon. The four who were sent proved so satisfactory that the company has again returned to Messrs. Glenfield & Kennedy for its recruits.

A SCOTTISH ENGINEERING CENTRE, with headquarters in Glasgow, is to be established. The object is to provide club rooms at a rendezvous for engineers, etc., to provide trade journals and books of reference, and a secretariat for the use of business men desiring to transact urgent business on the premises. The centre will also be available for the display of apparatus, appliances, machinery, tools, and other equipment and materials of all kinds used in modern engineering practice, and a technical service will be maintained. Rooms will be set aside for use by technical associations for meetings.

IN PARLIAMENT

Steel Output

MR. TURNER-SAMUELS asked the President of the Board of Trade what was the output of steel during the year 1939 in the following countries:—Germany, including Austria and the Saar, U.S.A. and Great Britain; what was the output for those countries during the year 1945; and what was the number of people employed in the industry in each of those countries during the same years.

SIR S. CRIPPS, in reply, gave the following details of production of steel ingots and castings during 1939 and 1945 respectively, the figures being in million tons:—Germany (including Austria and the Saar), 22.0, 2.0 (excluding the Saar); United States, 47.1, 71.4; United Kingdom, 13.2, 11.8. No information about the numbers employed in the steel industry in Germany was available. For the United States the figures included blast furnaces as well as steelworks and rolling mills, 389,000 being employed on the average in 1939 and 457,000 in August, 1945. In the United Kingdom, 178,400 were employed in steelworks and rolling mills in 1939 and 174,800 in 1945, both figures relating to the middle of the year.

Lead Supplies

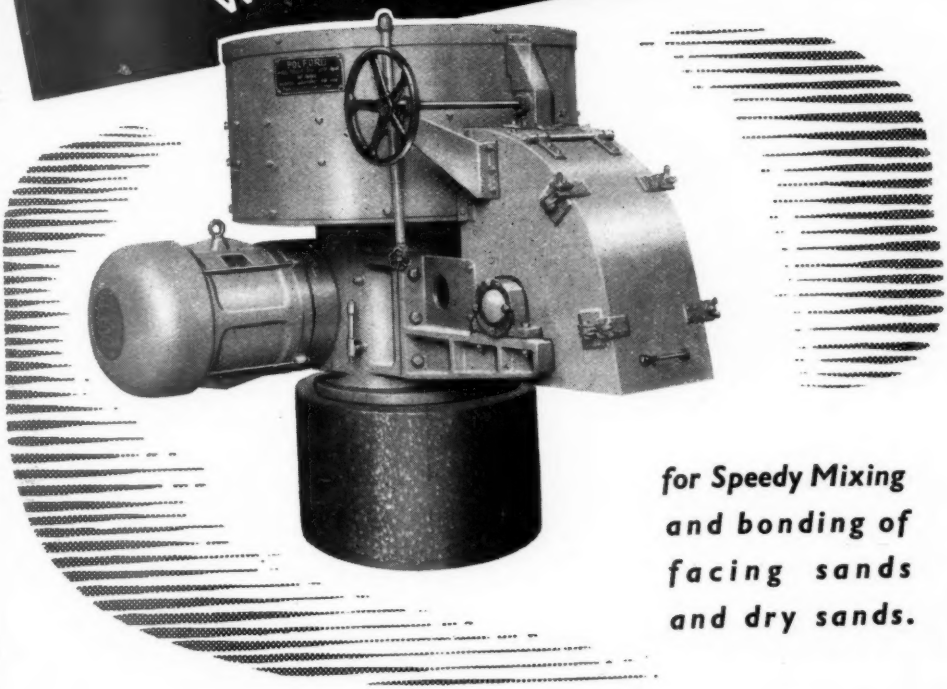
Replying to MR. CARSON, on behalf of the Minister of Supply and of Aircraft Production, MR. LEONARD said there was at present a severe world shortage of lead, of which there would not be enough to meet all requirements in 1946, but, so far as he was aware, building operations were not being held up through this shortage. Arrangements to ensure that the available supplies were allocated to the best advantage were at present under consideration and would take into account both the relative importance of the various uses and the possibility of using alternative materials.

AN AMERICAN FIRM, Wright Austin Company, of 345, Woodbridge Street, Detroit, 26, Michigan, has placed on the market completely transparent machine guards made from plastics.

THE DEATH IS ANNOUNCED from Paris of Mr. J. Cury, who was president of the Association Technique de Fonderie in 1931-32. He was a foundry owner at Deville and was an officer of the Legion of Honour.

PAT. Nº 570997

"POLFORD" REGISTERED MOTOR DRIVEN MIXER MILLER WITH DISINTEGRATOR



for Speedy Mixing and bonding of facing sands and dry sands.

SOLE AGENTS :

THOS. W. WARD, LIMITED. Albion Works, Sheffield

TELEPHONE: 26311 TELEGRAMS: FORWARD SHEFFIELD

COMPANY RESULTS

(Figures for previous year in brackets.)

Wales—Interim dividend of 5% (same).

Qualcast—Interim dividend of 10% (same).

United Steel Companies—Interim dividend of 2½% (same).

International Combustion—Final dividend of 27½%, making 32½% (same).

Midland Electric Manufacturing—Ordinary dividend of 15% (10%) and a cash bonus of 15% (same).

Bairds & Scottish Steel—Consideration of an ordinary dividend is deferred until the accounts for the year are completed.

L. Gardner & Sons—Net profit for 1945, after depreciation and taxation, £39,272 (£47,059); dividend of 50% (same); forward, £248,553 (£248,304).

S. E. Opperman—Net profit for the year to July 31, £39,546 (£92,964); to reserve for taxation, £26,500 (£78,830); dividend of 10% (12½%); to staff fund, £500; forward, £23,031 (£20,485).

Crosthwaite Furnaces & Scriven Machine Tools—Net profit for 1945, after taxation, etc., £4,441 (£4,001); dividend of 10% (same) and a bonus of 5% (same); to general reserve, £500 (same); forward, £2,817 (£2,549).

Waygood-Otis—Profit for 1945, £93,652 (£93,162); to directors' fees, £1,400 (£1,525); pensions reserve, £10,000 (same); ordinary dividend of 25% (same), £72,500; 6% preference dividend, £9,000 (same); forward, £15,208 (£14,456).

Vickers—Final dividends of 2½%, less tax, on the preferred stock, 2½%, less tax, on the preference stock, and 2½%, free of income-tax up to 6s. in the £, on the cumulative preference stock, making in each case 5% for the year ended December 31, 1945.

Bruce Peebles—Net profit for 1945, before depreciation, £46,367 (£42,554); to depreciation, £20,000 (same); 7½% participating preference dividend and further dividend of 2½%, making 10% (same); ordinary dividend of 5% and a bonus of 3%, making 8% (same).

Switchgear & Cowans—Profit for 1945, after providing for depreciation and taxation, but before war contingencies, £20,376 (£22,632, after providing for war contingencies); dividend of 20% (same), plus a bonus of 5% (nil); to reserve, £2,000 (£2,324); forward, £22,268 (£20,392).

Redpath Brown & Company—Net profit for the year ended July 31, 1945, after £5,463 for staff fund, £15,000 for depreciation, and £71,374 for tax provision, £127,048 (£49,952); to general reserve, £50,000 (nil); tax free dividend on the ordinary capital, £71,798 (£44,702); forward, £172,244 (same).

Edwin Showell & Sons—Net profit for the year ended June 30, after making all provisions, including taxation, £8,959; 6% cumulative preference dividend, £472; ordinary dividend of 10% and a bonus of 7½%, £1,620; to general reserve, £5,000; forward (subject to directors' fees), £4,685 (£2,819, after fees).

Smith's Dock—Profit for the year to September 30, £273,455 (£287,250); net profit, £168,835 (£135,766); income-tax, £85,000 (£91,000); ordinary dividend of 7% (6%); to plant improvement and extension reserve, £30,000 (£10,000 to general reserve); to staff and supplementary pension funds, £15,000 (nil); forward, £26,549 (£27,714).

Clarke, Chapman—Profit for 1945, after taxation, etc., £130,776 (£135,292); to depreciation, £24,069 (£25,275); directors' fees, £3,310 (£2,615); net profit, £103,397 (£107,402); preference dividend, £4,890 (same); ordinary dividend of 12½% (same); to general reserve, £20,000 (same); staff pensions reserve, £15,000 (£20,000); forward, £44,922 (£41,415).

Henry Meadows—Gross trading profit to August 31, 1944, £206,885; to depreciation, £47,676; taxation, £130,000; net profit, £27,951; gross trading profit to August 31, 1945, £118,469; to depreciation, £75,257; taxation, after adjustment for E.P.T. recoverable, £10,000; net profit, £31,873; additional provision of £38,500 made for taxation to meet liabilities now ascertained relating to previous periods; written off buildings in respect of war-time emergency expenditure, £10,351; transferred from obsolescence reserve, £25,000; transferred from contingency reserve, £15,000; final dividend of 17½%, making 25% (same); forward, £11,364.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

M. & C. Engineering Company, Wycliffe Works, Herries Street, London, W.10—£1,000.

Dawson's Pattern Works, 8, Alpha Street, Leeds—Patternmakers. £3,000. T. W. and C. Dawson.

British Pinions—Engineers, etc. £2,500. W. A. Hadley, 18, Austin Friars, London, E.C.2, subscriber.

L. A. Collins & Company, 9a, Pinner Road, Watford—Precision engineers. £5,000. L. A. Collins.

Stirling Vitreous Enamels, 84, Chancery Lane, London, W.C.2—£25,000. S. G. Harpour and A. E. Brooke.

Freeman Sanders Engine Company, Redinnick House, Penzance, Cornwall—£100. A. F. and E. G. Sanders.

Platt & Headworth, 32, Savile Row, Burlington Gardens, London, W.1—Ironfounders, etc. £2,500. A. D. Platt, F. V. Headworth, and A. M. Davis.

S.R.F., 1-3, Market Square, Bishops Stortford, Herts—Manufacturers of and dealers in agricultural machinery, etc. £3,000. V. H. Rowe, F. A. Sutton, and

Stone & Burton Company, Electroflo Building, Abbey Road, Park Royal, London, N.W.10—Metallurgists, manufacturers of furnaces, etc. £2,000. B. Dunglinson and C. H. Stone.

T. R. Wolverhampton, Southampton Street, Wolverhampton—Machinists, tool makers, etc. £7,000. T. Benton, E. T. Clark, A. T. Commander, J. H. Hughes, I. V. L. Jackson, S. Smith, and P. J. Thomas.